



UNIVERSITY OF JORDAN
FACULTY OF MEDICINE
BATCH 2013-2019



EPIDEMIOLOGY & BIOSTATISTICS

Slides Sheet Handout other.....

Number #1

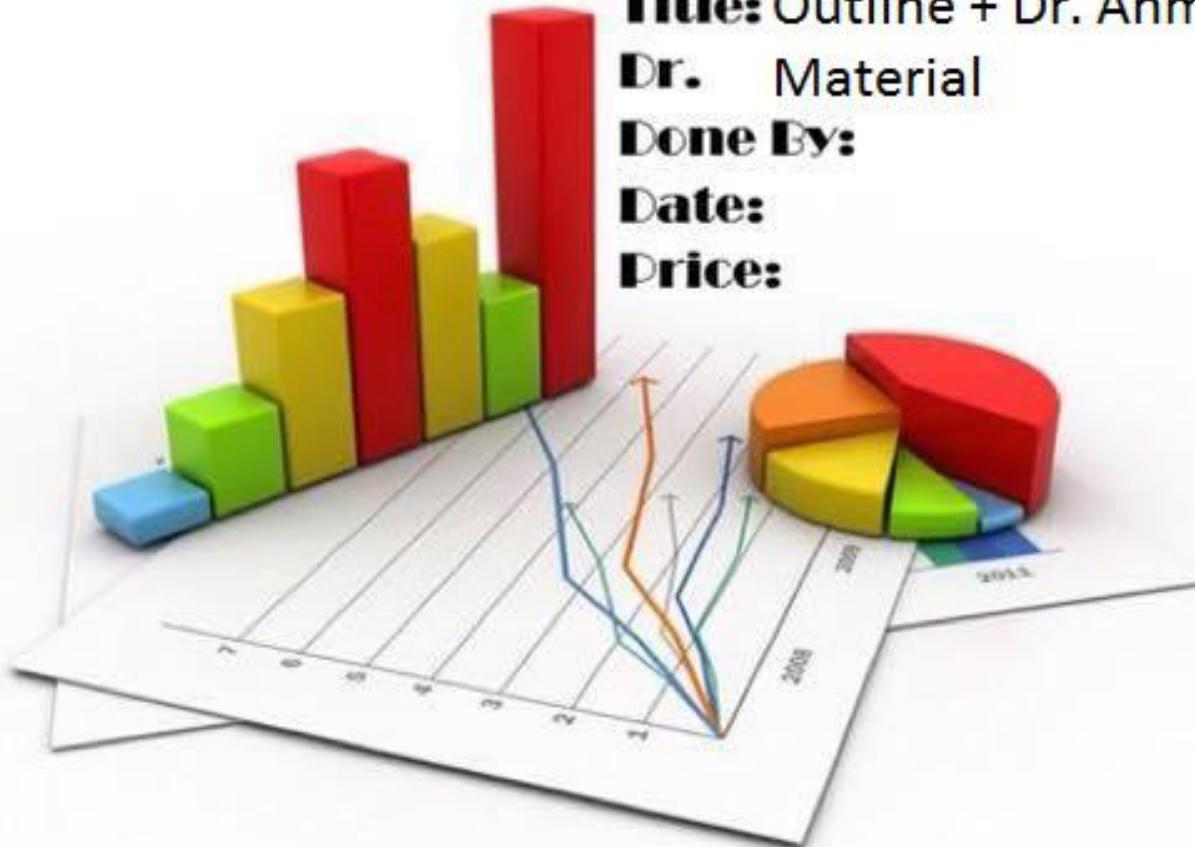
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DESIGNED BY NADEEN AL-FREIHAT

(19)

Example 3.4.1 A hospital administrator, who has been studying daily emergency admissions over a period of several years, has concluded that they are distributed according to the Poisson law. Hospital records reveal that emergency admissions have averaged three per day during this period. If the administrator is correct in assuming a Poisson distribution find the probability that

1. Exactly two emergency admissions will occur on a given day.

Solution We let λ be 3 and X be a random variable denoting the number of daily emergency admissions. Then, if X follows the Poisson distribution

$$\begin{aligned} P(X = 2) &= f(2) = \frac{e^{-3}3^2}{2!} \\ &= \frac{.050(9)}{2 \cdot 1} \\ &= .225 \end{aligned}$$

Values of e^x are available from most hand-held calculators.

2. No emergency admissions will occur on a particular day.

Solution

$$\begin{aligned} f(0) &= \frac{e^{-3}3^0}{0!} \\ &= \frac{.050(1)}{1} \\ &= .05 \end{aligned}$$

3. Either three or four emergency cases will be admitted on a particular day.

Solution Since the two events are mutually exclusive, we use the addition rule to obtain

$$\begin{aligned} f(3) + f(4) &= \frac{e^{-3}3^3}{3!} + \frac{e^{-3}3^4}{4!} \\ &= \frac{.05(27)}{3 \cdot 2 \cdot 1} + \frac{.05(81)}{4 \cdot 3 \cdot 2 \cdot 1} \\ &= .225 + .16875 \\ &= .39 \end{aligned}$$

In the foregoing example the probabilities were evaluated directly from the equation. We may, however, use Appendix Table B, which gives cumulative probabilities for various values of λ and X .

Example 3.4.2 In the study of a certain aquatic organism, a large number of samples were taken from a pond, and the number of organisms in each sample was counted. The average number of organisms per sample was found to be two. Assuming that the number of organisms follows a Poisson distribution, find the probability that:

1. The next sample taken will contain one or fewer organisms.

Solution In Table B we see that when $\lambda = 2$, the probability that $X \leq 1$ is .406. That is, $P(X \leq 1|2) = .406$.

2. The next sample taken will contain exactly three organisms.

Solution

$$P(X = 3|2) = P(X \leq 3) - P(X \leq 2) = .857 - .677 = .180$$

3. The next sample taken will contain more than five organisms.

Solution Since the set of more than five organisms does not include five we are asking for the probability that six or more organisms will be observed. This is obtained by subtracting the probability of observing five or fewer from 1. That is,

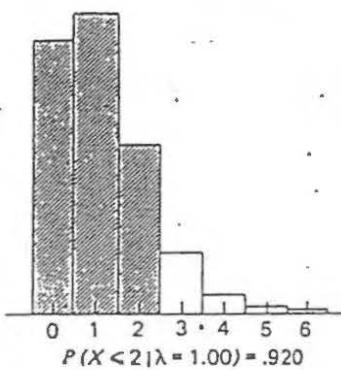
$$P(X > 5|2) = 1 - P(X \leq 5) = 1 - .983 = .017$$

(21)

APPENDIX

TABLE B

Cumulative Poisson Distribution $P(X \leq x|\lambda)$, 1000 Times the Probability of x or Fewer Occurrences of Event That Has Average Number of Occurrences Equal to λ



$x \setminus \lambda$	.02	.04	.06	.08	.10	.15	.20	.25
0	980	961	942	923	905	861	819	779
1	1000	999	998	997	995	990	982	974
2		1000	1000	1000	1000	999	999	998
3						1000	1000	1000
$x \setminus \lambda$	.30	.35	.40	.45	.50	.55	.60	.65
0	741	705	670	638	607	577	549	522
1	963	951	938	925	910	894	878	861
2	996	994	992	989	986	982	977	972
3	1000	1000	999	999	998	998	997	996
4			1000	1000	1000	1000	1000	999
5								1000
$x \setminus \lambda$	.70	.75	.80	.85	.90	.95	1.0	1.1
0	497	472	449	427	407	387	368	333
1	844	827	809	791	772	754	736	699
2	966	959	953	945	937	929	920	900
3	994	993	991	989	987	984	981	974
4	999	999	999	998	998	997	996	995
5	1000	1000	1000	1000	1000	1000	999	999
6							1000	1000

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APPENDIX

TABLE B (*Continued*)

"Continuous probability Distributions"

The Normal Distribution

- * - The most important distribution in all statistics.
- * - It is called the Gaussian Distribution.
- * - It is called also the bell-shaped CURVE.

The normal density is given by:

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\mu)^2/2\sigma^2} \quad \text{where } -\infty < x < \infty$$

$f(x)$ = probability distribution of the Continuous Random Variable X .
 $\pi = 3.14159$ (constant)
 $e = 2.71828$ (constant)

The two parameters of the distribution are.

- * μ - the mean
- * σ - the standard deviation

* Characteristics of the Normal Distribution

The Unit Normal or Standard Normal Distribution

The normal distribution is really a family of distributions in which one member is distinguished from another on the basis of the values of μ and σ . The most important member of this family is the Unit normal

Standard normal distribution, so called because it has a mean of zero and a standard deviation

of 1, $\mu = 0, \sigma = 1$ ①

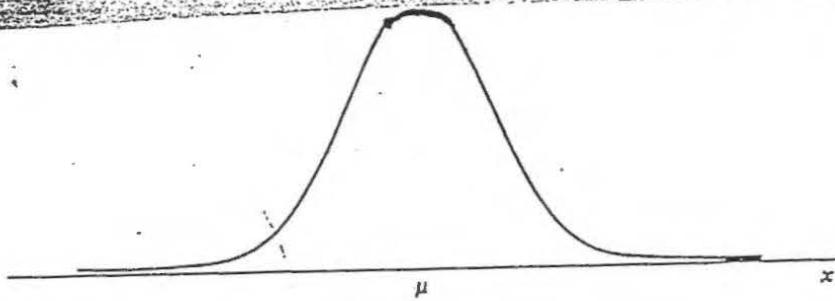


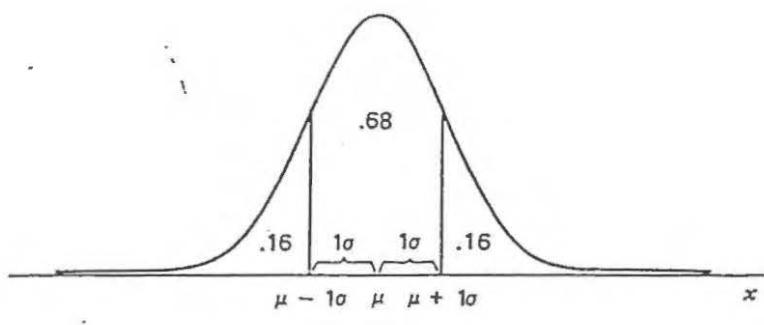
FIGURE 3.6.1
Graph of a Normal Distribution

Characteristics of the Normal Distribution

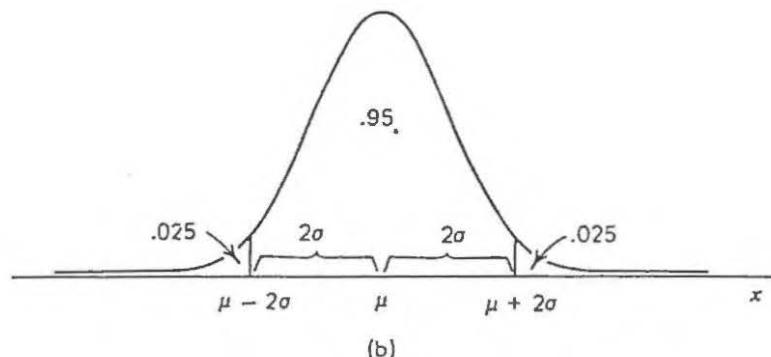
1. It is symmetrical about its mean, μ . As is shown in Figure 3.6.1, the curve on either side of μ is a mirror image of the other side.
2. The mean, the median, and the mode are all equal.
3. The total area under the curve above the x -axis is one square unit. This characteristic follows from the fact that the normal distribution is a probability distribution. Because of the symmetry already mentioned, 50 percent of the area is to the right of a perpendicular erected at the mean, and 50 percent is to the left.
4. If we erect perpendiculars a distance of 1 standard deviation from the mean in both directions, the area enclosed by these perpendiculars, the x -axis, and the curve will be approximately 68 percent of the total area. If we extend these lateral boundaries a distance of 2 standard deviations on either side of the mean, approximately 95 percent of the area will be enclosed, and extending them a distance of 3 standard deviations will cause approximately 99.7 percent of the total area to be enclosed. These approximate areas are illustrated in Figure 3.6.2.
5. The normal distribution is completely determined by the parameters μ and σ . In other words, a different normal distribution is specified for each different value of μ and σ . Different values of μ shift the graph of the distribution along the x -axis as is shown in Figure 3.6.3. Different values of σ determine the degree of flatness or peakedness of the graph of the distribution as is shown in Figure 3.6.4.

PROBABILITY DISTRIBUTIONS

(3)



(a)



(b)

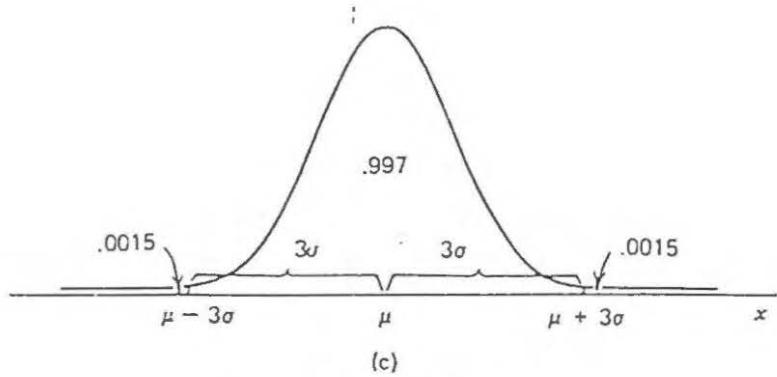


FIGURE 3.6.2

Subdivision of the Area Under the Normal Curve (Areas Are Approximate)

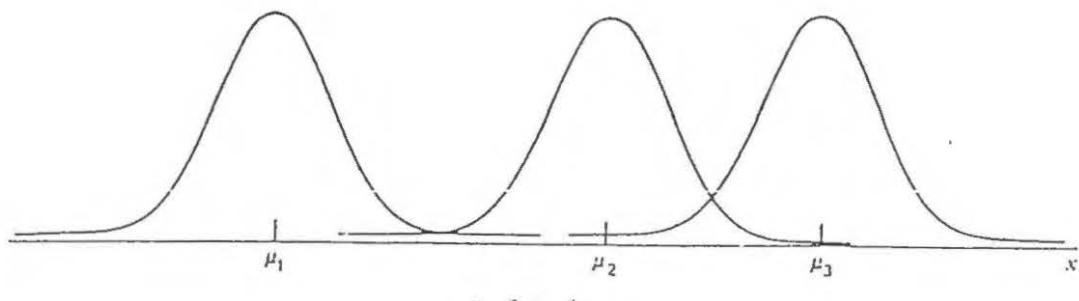


FIGURE 3.6.3

Three Normal Distributions with Different Means

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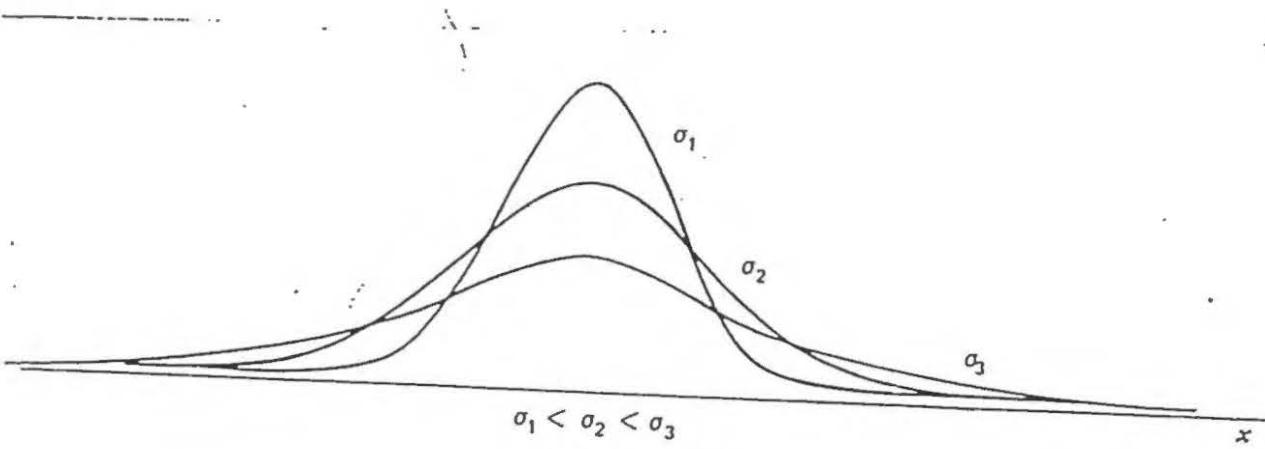


FIGURE 3.6.4
Three Normal Distributions with Different Standard Deviations

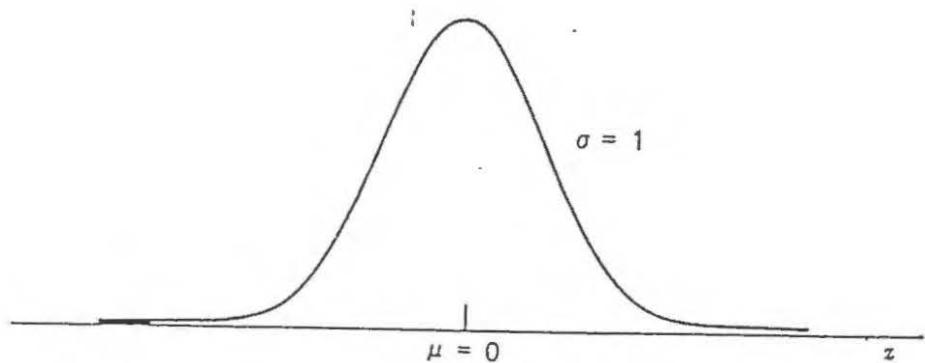


FIGURE 3.6.5
The Unit Normal Distribution

(5)

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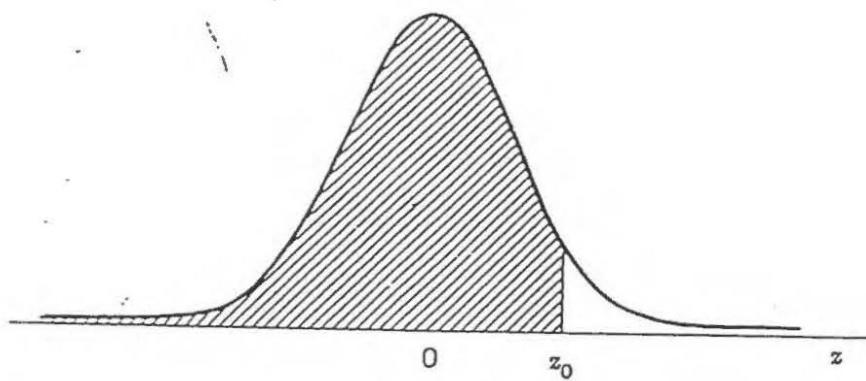


FIGURE 3.6.6

Area Given by Appendix Table C

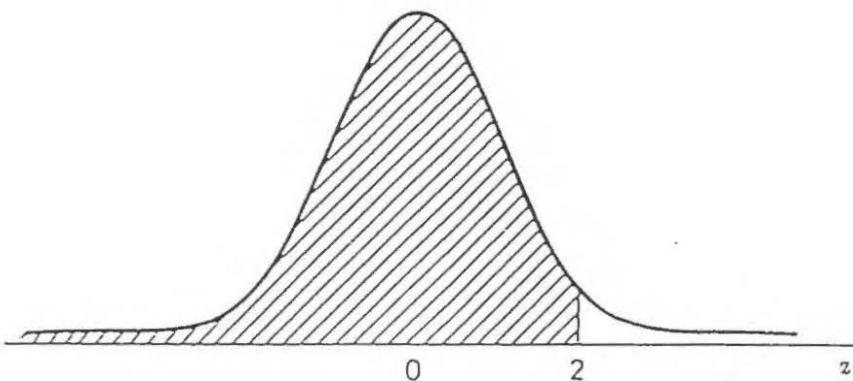


FIGURE 3.6.7

(c)

(6)

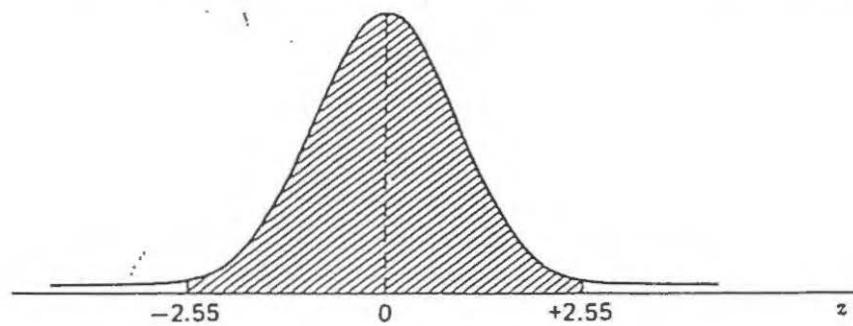


FIGURE 3.6.8
Unit Normal Curve Showing $P(-2.55 < z < 2.55)$

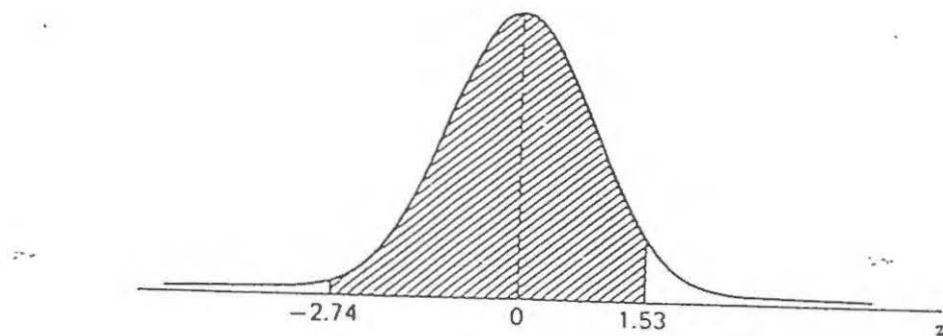


FIGURE 3.6.9
Unit Normal Curve Showing Proportion of z Values Between
 $z = -2.74$ and $z = 1.53$

(7)

(7)

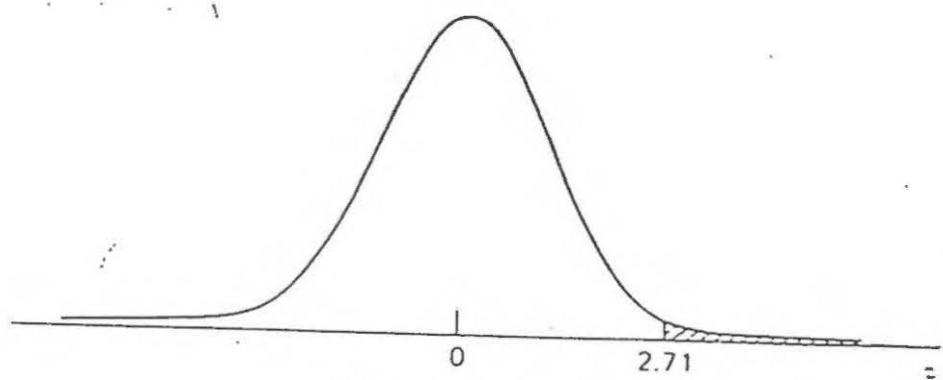


FIGURE 3.6.10
Unit Normal Distribution Showing $P(z \geq 2.71)$

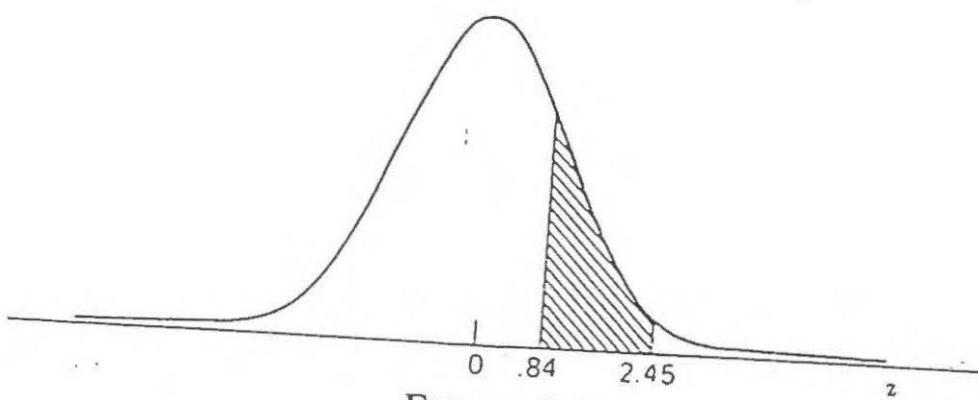


FIGURE 3.6.11
Unit Normal Curve Showing $P(0.84 \leq z \leq 2.45)$

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The random variable that results, $\frac{X-M}{\sigma}$, is usually designated by the letter Z , so the equation for the unit normal distribution is:

$$f(Z) = \frac{1}{\sqrt{2\pi}} e^{-Z^2/2} \quad \text{where } -\infty < Z < \infty$$

Table C provide the possible values of $P(Z \leq Z_0)$ \Rightarrow The area under the curve above the Z -axis between $-\infty$ and Z .

Example: Given the unit normal distribution, find the area under the curve, above the Z -axis between $-\infty$ and $Z = 2$.

Solution: Fig 3.6.7

From Table C $P = 0.9772$

Example: What is the probability that a Z picked at random from the population of Z 's will have a value between -2.55 and $+2.55$?

Solution: Fig 3.6.8 from Table C :

$$P(-2.55 < Z < 2.55) = 0.9946 - 0.0054 = 0.9892$$

(1)

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Example: What proportion of Z values are between -2.74 and 1.53 ?

Solution: Fig 3.6.9 from Table C:

$$P(-2.74 \leq Z \leq 1.53) = 0.9370 - 0.0031 = 0.9339$$

Example: Given the Unit Normal distribution, find $P(Z \geq 2.71)$

Solution: Fig 3.6.10 $\Rightarrow P(Z \geq 2.71) = 1 - P(Z \leq 2.71)$

$$P = 1 - 0.9966 = 0.0034$$

Example: Given the Unit normal distribution, find $P(0.84 \leq Z \leq 2.45)$

Solution: Fig 3.6.11 \Rightarrow

$$P(0.84 \leq Z \leq 2.45) = P(Z \leq 2.45) - P(Z \leq 0.84)$$

$$P = 0.9929 - 0.7995 = 0.1934$$

(9)

(10)

Approximately Normally distributed

It is possible for any normal distribution to be transformed easily to the unit normal, this is done by the following formula:

$$Z = \frac{X - M}{\sigma}$$

Example A physical therapist feels that scores on a certain manual dexterity test are approximately normally distributed with a mean of 10 and Standard deviation of 2.5. If a randomly selected individual takes the test, what is the probability that he or she will make a score of 15 or better?

Solution:

$$Z = \frac{X - M}{\sigma} = \frac{15 - 10}{2.5} = \frac{5}{2.5} = 2$$

$$P(X \geq 15) = P\left(z \geq \frac{15 - 10}{2.5}\right) = P(z \geq 2) = 0.0228$$

the probability that a randomly chosen individual taking the test will make a score of 15 or better is 0.0228.

(11)

(11)

Example: Suppose it is known that the weights of a certain group of individuals are approximately normally distributed with a mean of 140 pounds and a standard deviation of 25 pounds. What is the probability that a person picked at random from this group will weigh between 100 and 170 pounds?

$$Z = \frac{X - \mu}{\sigma} = \frac{100 - 140}{25} = -1.6$$

$$Z = \frac{170 - 140}{25} = 1.2$$

from Table C: $P(Z \leq -1.6) = 0.0548$

$$P(Z \leq 1.2) = 0.8849$$

$$\begin{aligned} P(100 \leq X \leq 170) &= P\left(\frac{100 - 140}{25} \leq Z \leq \frac{170 - 140}{25}\right) \\ &= P(-1.6 \leq Z \leq 1.2) \\ &= P(-\infty \leq Z \leq 1.2) - P(-\infty \leq Z \leq -1.6) \\ &= 0.8849 - 0.0548 \\ &= 0.8301 \end{aligned}$$

Example: In a population of 10,000 people in previous example how many you expect to weigh more than 200 pounds?

$$P(X > 200) = P\left(\frac{200 - 140}{25}\right) = P(Z > 2.4) = 1 - 0.9918 = 0.0082$$

$$10,000 \times 0.0082 = 82 \text{ persons weigh more than } 200 \text{ pounds.}$$

(11)

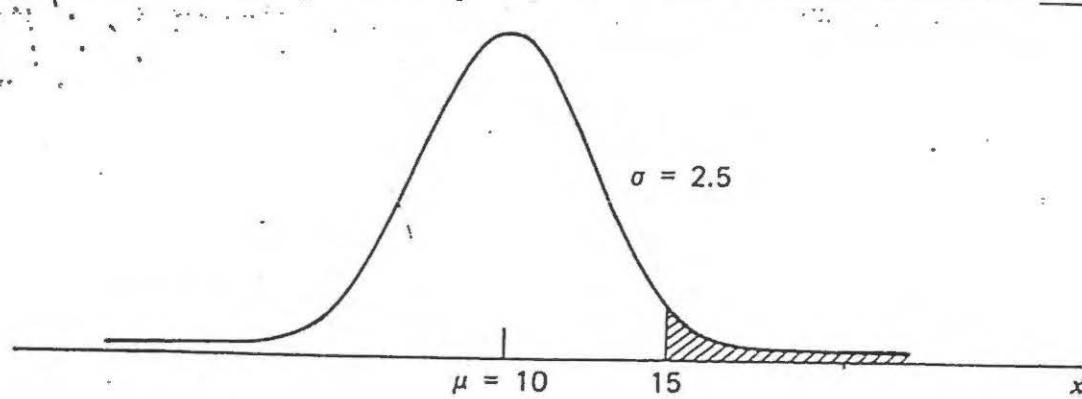


FIGURE 3.6.12

Normal Distribution to Approximate Distribution of Scores on a Manual Dexterity Test

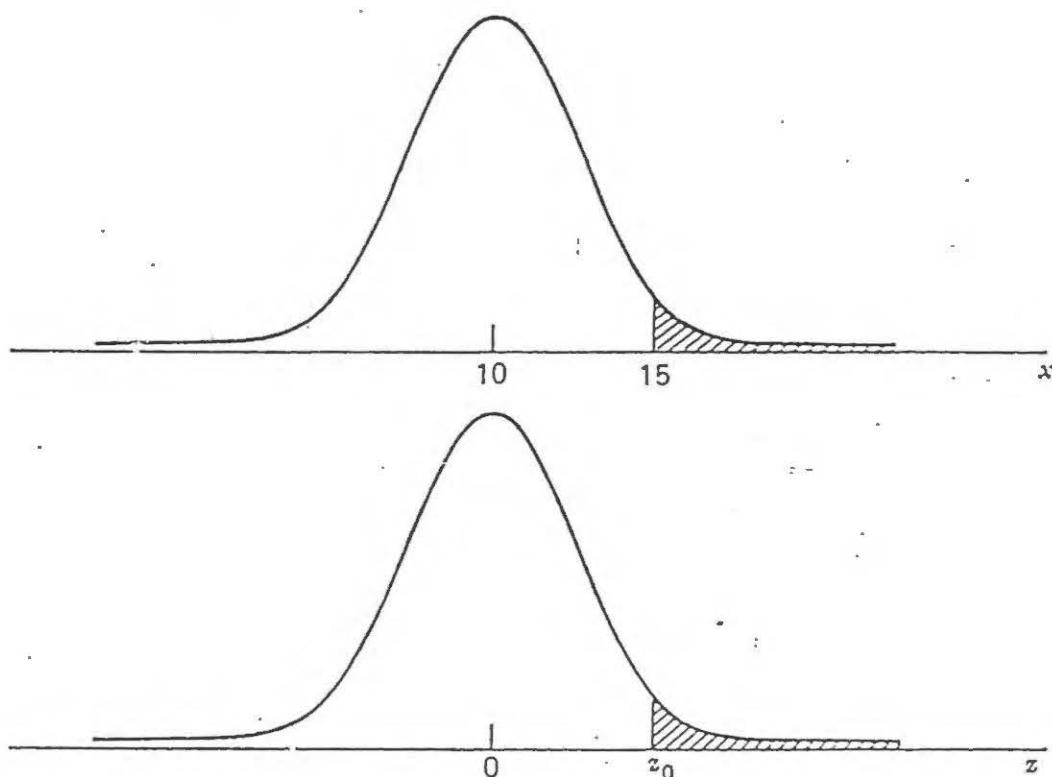


FIGURE 3.6.13

(13)

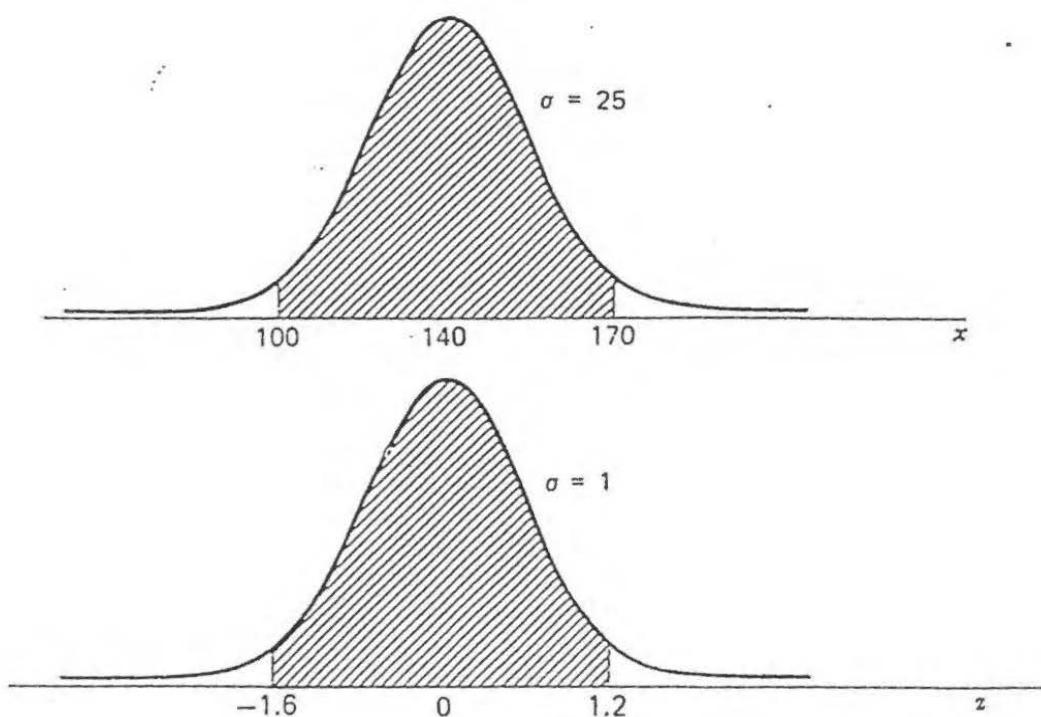


FIGURE 3.6.14

Distribution of Weights (x) and the Corresponding Unit Normal Distribution (z)

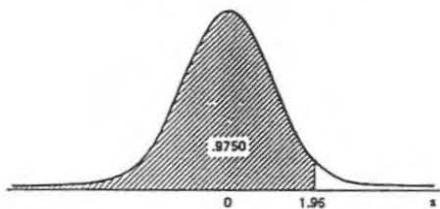
(14)

(14)

APPENDIX

TABLE C

Normal Curve Areas $P(z \leq z_0)$ Entries in the Body of the Table are Areas
Between $-\infty$ and z



z	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	0.00	z
-3.80	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	-3.80
-3.70	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	-3.70
-3.60	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0002	-3.60
-3.50	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	-3.50
-3.40	.0002	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	-3.40
-3.30	.0003	.0004	.0004	.0004	.0004	.0004	.0004	.0005	.0005	.0005	-3.30
-3.20	.0005	.0005	.0005	.0006	.0006	.0006	.0006	.0006	.0007	.0007	-3.20
-3.10	.0007	.0007	.0008	.0008	.0008	.0008	.0009	.0009	.0009	.0010	-3.10
-3.00	.0010	.0010	.0011	.0011	.0011	.0012	.0012	.0013	.0013	.0013	-3.00
-2.90	.0014	.0014	.0015	.0015	.0016	.0016	.0017	.0018	.0018	.0019	-2.90
-2.80	.0019	.0020	.0021	.0021	.0022	.0023	.0023	.0024	.0025	.0026	-2.80
-2.70	.0026	.0027	.0028	.0029	.0030	.0031	.0032	.0033	.0034	.0035	-2.70
-2.60	.0036	.0037	.0038	.0039	.0040	.0041	.0043	.0044	.0045	.0047	-2.60
-2.50	.0048	.0049	.0051	.0052	.0054	.0055	.0057	.0059	.0060	.0062	-2.50
-2.40	.0064	.0066	.0068	.0069	.0071	.0073	.0075	.0078	.0080	.0082	-2.40
-2.30	.0084	.0087	.0089	.0091	.0094	.0096	.0099	.0102	.0104	.0107	-2.30
-2.20	.0110	.0113	.0116	.0119	.0122	.0125	.0129	.0132	.0136	.0139	-2.20
-2.10	.0143	.0146	.0150	.0154	.0158	.0162	.0166	.0170	.0174	.0179	-2.10
-2.00	.0183	.0188	.0192	.0197	.0202	.0207	.0212	.0217	.0222	.0228	-2.00
-1.90	.0233	.0239	.0244	.0250	.0256	.0262	.0268	.0274	.0281	.0287	-1.90
-1.80	.0294	.0301	.0307	.0314	.0322	.0329	.0336	.0344	.0351	.0359	-1.80
-1.70	.0367	.0375	.0384	.0392	.0401	.0409	.0418	.0427	.0436	.0446	-1.70
-1.60	.0455	.0465	.0475	.0485	.0495	.0505	.0516	.0526	.0537	.0548	-1.60
-1.50	.0559	.0571	.0582	.0594	.0606	.0618	.0630	.0643	.0655	.0668	-1.50
-1.40	.0681	.0694	.0708	.0721	.0735	.0749	.0764	.0778	.0793	.0808	-1.40
-1.30	.0823	.0838	.0853	.0869	.0885	.0901	.0918	.0934	.0951	.0968	-1.30
-1.20	.0985	.1003	.1020	.1038	.1056	.1075	.1093	.1112	.1131	.1151	-1.20
-1.10	.1170	.1190	.1210	.1230	.1251	.1271	.1292	.1314	.1335	.1357	-1.10
-1.00	.1379	.1401	.1423	.1446	.1469	.1492	.1515	.1539	.1562	.1587	-1.00
-0.90	.1611	.1635	.1660	.1685	.1711	.1736	.1762	.1788	.1814	.1841	-0.90
-0.80	.1867	.1894	.1922	.1949	.1977	.2005	.2033	.2061	.2090	.2119	-0.80
-0.70	.2148	.2177	.2206	.2236	.2266	.2296	.2327	.2358	.2389	.2420	-0.70
-0.60	.2451	.2483	.2514	.2546	.2578	.2611	.2643	.2676	.2709	.2743	-0.60
-0.50	.2776	.2810	.2843	.2877	.2912	.2946	.2981	.3015	.3050	.3085	-0.50
-0.40	.3121	.3156	.3192	.3228	.3264	.3300	.3336	.3372	.3409	.3446	-0.40
-0.30	.3483	.3520	.3557	.3594	.3632	.3669	.3707	.3745	.3783	.3821	-0.30
-0.20	.3859	.3897	.3936	.3974	.4013	.4052	.4090	.4129	.4168	.4207	-0.20
-0.10	.4247	.4286	.4325	.4364	.4404	.4443	.4483	.4522	.4562	.4602	-0.10
0.00	.4641	.4681	.4721	.4761	.4801	.4840	.4880	.4920	.4960	.5000	0.00

(15)

(15)

APPENDIX

TABLE C (*Continued*)

<i>z</i>	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	<i>z</i>
0.00	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359	0.00
0.10	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753	0.10
0.20	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141	0.20
0.30	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517	0.30
0.40	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879	0.40
0.50	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224	0.50
0.60	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549	0.60
0.70	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852	0.70
0.80	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133	0.80
0.90	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389	0.90
1.00	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621	1.00
1.10	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830	1.10
1.20	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015	1.20
1.30	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177	1.30
1.40	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319	1.40
1.50	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441	1.50
1.60	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545	1.60
1.70	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633	1.70
1.80	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706	1.80
1.90	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767	1.90
2.00	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817	2.00
2.10	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857	2.10
2.20	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890	2.20
2.30	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916	2.30
2.40	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936	2.40
2.50	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952	2.50
2.60	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964	2.60
2.70	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974	2.70
2.80	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981	2.80
2.90	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986	2.90
3.00	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990	3.00
3.10	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993	3.10
3.20	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995	3.20
3.30	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997	3.30
3.40	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998	3.40
3.50	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	3.50
3.60	.9998	.9998	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	3.60
3.70	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	3.70
3.80	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	3.80

(10)

Hypothesis Testing

The purpose of hypothesis testing is to aid the clinician, researcher, or administrator in reaching a decision concerning a population by examining a sample from that population.

A hypothesis is defined as a statement about one or more populations.

- * e.g.: A hospital administrator may hypothesize that the average length of stay of patients admitted to the hospital is five days.
- * A public health nurse may hypothesize that a particular educational program will result in improved communication between nurse and patient.
- * A physician may hypothesize that a certain drug will be effective in 90% of the cases with which it is used.