**1999 to 2017 United States Unintentional Death Formal Report**

Submitted to

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Probability and Applied Statistics

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12/06/2022

By

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This formal report will examine data from the National Center for Health Statistics. The data represents the number of deaths in each state in the United States, including Washington D.C., caused by unintentional injuries. The data set records the number of deaths caused by unintentional injuries from the years 1999 - 2017. The recorded number of deaths range from 145 to 13,840 deaths. Also, the age-adjusted death rate of each state is reported from the data set. The age-adjusted death rate ranges from 19.6 to 100.3. The data set will be incorporated into different word problems from the textbook Mathematical Statistics with Applications by Wackery, Mendenhall, and Scheaffer (7th edition), which will be solved using the different formulas learned in each chapter (1 to 5).

The following topics from chapter one will be used to create word problems histogram, mean, median, mode, standard deviation, variance, will be used to form word problems based on the data set. The following topics from chapter two will be used to create word problems: set notation, multinomial coefficients, permutation, combination, conditional probability, multiplicative and additive law, and Bayes theorem. The following topics from chapter three will be used to create word problems: binomial distribution, geometric distribution, hypergeometric distribution, Poisson probability distribution, and Tcheysheff’s theorem. The following topics from chapter four will be used to create word problems: continuous random variables and uniform distribution. The following topics from chapter five will be used to create word problems: discrete bivariate and multivariate. For this report to be able to use all the data values to create and solve problems for each topic, from 1999 to 2017 of each state in the United States and Washington D.C, the mean death rate and age death rate.

**Chapter 1**

Histogram of 1998 to 2017 deaths from unintentional injuries in United States

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Mean and Standard Deviation of death rate and age death rate caused by unintentional injuries by state ranging from 1999-2017.

|  |  |  |
| --- | --- | --- |
| State | Mean Death Rate by State  (1999-2017) | Mean Age Death Rate by State  (1999-2017) |
| Alabama | 2414.26 | 50.95 |
| Alaska | 354.95 | 354.95 |
| Arizona | 3060.21 | 49.24 |
| Arkansas | 1422.47 | 48.72 |
| California | 10945.32 | 29.72 |
| Colorado | 2159.21 | 45.16 |
| Connecticut | 1390.74 | 36.18 |
| Delaware | 358.68 | 40.04 |
| District of Columbia | 225.58 | 36.79 |
| Florida | 8854.53 | 44.02 |
| Georgia | 3792.21 | 42.62 |
| Hawaii | 444.37 | 30.93 |
| Idaho | 674.47 | 45.31 |
| Illinois | 4415.89 | 34.05 |
| Indiana | 2662.05 | 41.03 |
| Iowa | 1284.37 | 37.76 |
| Kansas | 1257.79 | 42.57 |
| Kentucky | 2458.37 | 57.18 |
| Louisiana | 2331.89 | 51.79 |
| Maine | 609.37 | 42.63 |
| Maryland | 1572.84 | 27.13 |
| Massachusetts | 2166.47 | 30.49 |
| Michigan | 3870.95 | 37.63 |
| Minnesota | 2132.26 | 38.02 |
| Mississippi | 1716.47 | 58.71 |
| Missouri | 2957.26 | 48.36 |
| Montana | 562.26 | 54.86 |
| Nebraska | 717.68 | 37.15 |
| Nevada | 1080.95 | 42.80 |
| New Hampshire | 541.53 | 39.75 |
| New Jersey | 2726.05 | 29.83 |
| New Mexico | 1271.32 | 64.57 |
| New York | 5433.95 | 29.01 |
| North Carolina | 3696.21 | 44.92 |
| North Dakota | 1156.63 | 43.12 |
| Ohio | 4516.16 | 42.29 |
| Oklahoma | 2062.16 | 54.43 |
| Oregon | 2340.32 | 42.17 |
| Pennsylvania | 5067.63 | 42.71 |
| Rhode Island | 700.47 | 37.92 |
| South Carolina | 2037.05 | 50.34 |
| South Dakota | 812.26 | 48.07 |
| Tennessee | 4008.42 | 50.53 |
| Texas | 8035.79 | 39.75 |
| Utah | 816.00 | 39.79 |
| Vermont | 656.58 | 42.35 |
| Virginia | 2785.79 | 36.24 |
| Washington | 2462.63 | 44.35 |
| West Virginia | 1406.37 | 59.41 |
| Wisconsin | 2296.89 | 43.85 |
| Wyoming | 305.53 | 56.61 |

Mean, Median and Mode death rate caused by unintentional injuries by year within the United States (1999-2017).

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Mean Death Rate by Year | Median Death Rate by Year | Mode Death Rate by Year |
| 1999 | 1918.82 | 1519 | 2214 |
| 2000 | 1919.61 | 1566 | 343 |
| 2001 | 1990.92 | 1571 | N/A |
| 2002 | 2091.98 | 1580 | N/A |
| 2003 | 2142.69 | 1656 | N/A |
| 2004 | 2196.31 | 1703 | N/A |
| 2005 | 2309.98 | 1922 | N/A |
| 2006 | 2384.29 | 1917 | N/A |
| 2007 | 2425.61 | 2056 | N/A |
| 2008 | 2390.24 | 2012 | N/A |
| 2009 | 2314.14 | 1875 | N/A |
| 2010 | 2369.78 | 1999 | N/A |
| 2011 | 2479.18 | 2091 | N/A |
| 2012 | 2505.73 | 2195 | N/A |
| 2013 | 2559.94 | 2287 | N/A |
| 2014 | 2665.25 | 2344 | N/A |
| 2015 | 2873.94 | 2433 | N/A |
| 2016 | 3164.20 | 2592 | 371 |
| 2017 | 3332.08 | 2563 | N/A |

Standard Deviation and variance death rate caused by unintentional injuries by year within the United States (1999-2017).

|  |  |  |
| --- | --- | --- |
| Year | Standard Deviation Death Rate by Year | Variance Death Rate by Year |
| 1999 | 1851.26 | 3427160.748 |
| 2000 | 1811.41 | 3281192.244 |
| 2001 | 1872.48 | 3506190.713 |
| 2002 | 2057.25 | 4232259.78 |
| 2003 | 2123.45 | 4509025.378 |
| 2004 | 2162.74 | 4677443.101 |
| 2005 | 2270.74 | 5156269.022 |
| 2006 | 2338.31 | 5467683.854 |
| 2007 | 2388.40 | 5704472.841 |
| 2008 | 2297.76 | 5279714.864 |
| 2009 | 2272.69 | 5165120.6 |
| 2010 | 2269.12 | 5148885.452 |
| 2011 | 2336.94 | 5461283.908 |
| 2012 | 2343.82 | 5493469.242 |
| 2013 | 2402.675 | 5772844.777 |
| 2014 | 2506.23 | 6281178.312 |
| 2015 | 2694.25 | 7259008.534 |
| 2016 | 3008.05 | 9048394.041 |
| 2017 | 3195.53 | 10211383.04 |

**Chapter 2**

*Problem 2.10 Set Notation*

A researcher conducted a study finding the cause of death by unintentional injuries in the following states: NJ, NY, PA, and NH. The approximate average death caused by unintentional injuries are 0.20, 0.39, 0.37, and 0.04, respectively. (Wackerly et al., 2008)

1. List the sample space for this experiment

**S = {NJ, NJ, PA, NH}**

1. Assign probabilities to each of simple events

**P({NJ}) = 0.20**

**P({NY}) = 0.39**

**P({PA}) = 0.37**

**P({NH}) = 0.04**

1. What is the probability that the person chosen at random has either died in NJ or PA?

P({NJ}) or P({PA}) = P({NJ}) + P({PA})

= 0.20 + 0.39

**= 0.57**

*Problem 2.38 - Multinomial Coefficients*

A funeral home offers a special deal for deaths caused by unintentional injuries in which, for a fixed package cost, a family can select from 5 types of caskets, 3 types of flower arrangements, and 4 types of head stones. How many different packages are available if a package consists of one casket type, 1 flower arrangement type, and 1 head stone type? (Wackerly et al., 2008)

mn = 5(3)(4) = **60**

*Example 2.8 – Permutations*

The names of 3 people are to be randomly drawn, without replacement, from a bowl containing the names of 50 people. The person that is drawn first will have their death certificate written up within 1 day, the second draw will be within 3-5 days, and the three draw will be within 7-10 days. How many sample points are associated with this experiment? (Wackerly et al., 2008)

*Problem 2.54 – Combinations*

Due to a death ruled as unintentional, a group of 5 North Carolina and 4 South Carolina residents are available to fill a mortuary storage in Virginia. If 4 people are to be randomly selected from this group, find the probability that exactly 2 people are from North Carolina will be among the four chosen? (Wackerly et al., 2008)

10\*6 = 60

= **0.476**

*Problem 2.76 - Conditional* *Probability*

A survey of individuals in a particular community shown that 65% of people knew someone that passed away from an unintentional death in New Jersey. Half of the individuals came from Atlantic County, which contained 45% of the total surveyed individuals. Find the probability that an individual was (Wackerly et al., 2008)

1. An individual knowing someone whose cause of death was due to intentional injuries from Atlantic County
2. An individual not knowing someone whose cause of death was due to intentional injuries from Atlantic County

1 – P(U|A) = 1- 0.722 = **0.278**

*Problem 2.94 - Multiplicative Law and Additive Law*

A police station uses two systems to determine the if the cause of death of decreased an individual, A and B. If the cause was death was found, the probability it will be detected by system A is 0.97; by system B, 0.90. (Wackerly et al., 2008)

1. If the cause of death was detected, find the probability that the system would be able to detect the case of death by either system A or B or both devices.

1. Find the probability that the cause of death would be unknown.

*Problem 2.129 - Bayes Theorem*

Two different age groups are observed to want different things given a set of circumstances. It has been observed that 70% of those under the age of 40 prefer a cremation, whereas only 40% of those over 40 prefer a cremation burial. A group of 20 people, 15 under 40 years of age and 5 over the age of 40, were asked their burial preferences. A response picked at random from the 20 preferred a coffin burial. What is the probability that is was someone over the age of 40? (Wackerly et al., 2008)

P = Cremation Burial

N = Coffin Burial

U = Under 40 years

O = over 40 years

P (O) = 0.25

P (U) = 0.75

P (P | U) = 0.70

P (P | O) = 0.40  
P (N | O) = 1 – 0.6 = 0. 40

P (N | U) = 1 = 0.70 = 0.30

= = **0.40**

**Chapter 3**

*Problem 3.52 - Binomial Distribution*

If 70% of deaths caused by unintentional injuries from 1999-2017 within 50 US states and the District of Columbia were died under the age of 49, and 20 people are randomly selected, what is the probability that…… (Wackerly et al., 2008)

n = 20, p = 0.70%, q = 0.30

1. at least 17 deaths are under the age of 49

P(Y17) = P(Y=17) + P(Y=18) + P(Y=19) + P(Y=20)

= (0.7)17 (0.3)20-17 + (0.7)18 (0.3)20-18 + (0.7)19 (0.3)20-19 + (0.7)20 (0.3)20-20

= (0.7)20 (0.3)20-20 = 0.0716 + 0.0278 + 0.0068 + 0.0008 **= 0.1071**

1. fewer than 15 deaths are under the age of 49

P(Y < 15) = 1-P (Y15)

= 1- {P(Y=15) + P(Y=16) + P(Y=17) + P(Y=18) + P(Y=19) + P(Y=20)}

= 1- {P(Y=15) + P(Y=16) + P(Y17)}

= 1 – { (0.7)15 (0.3)20-15 + (0.7)16 (0.3)20-16 + 0.1071}

= 1 – 0.1789 + 0.1034 + 0.1071

= **0.5836**

*Problem 3.78 - Geometric Distribution*

Of a population of families with decreased individuals, 55% prefer a particular location gravesite. If a group of randomly selected families is interviewed, what us the probability that exactly five people have to be interviewed to encounter the first family who prefers gravesite location A? At least 5 people? (Wackerly et al., 2008)

P(X = 5) = (0.45)5-1(0.55) = **0.0226**

P(X > 5 ) = P(X > 4) = (0.45)5-1 = **0.0410**

*Problem 3.103 - Hypergeometric Distribution*

A funeral house contains 15 decreased persons, 5 of which are under 50 years old. A funeral director selects 4 decreased persons at random, thinking they have been embalmed. What is the probability that all 4 deceased persons are embalmed? (Wackerly et al., 2008)

N = 15, r = 5, n = 4

= =

*Problem 3.132 - Poisson Probability Distribution*

The mean number of decreased persons entering a hospital morgue per one-minute period is 5. An excessive number of decreased individuals entering the morgue during a brief period of time produces a hazardous situation. Find the probability that the number of bodies entering the morgue during the one-minute period exceeds 7 (Wackerly et al., 2008).

P (Y > 7) = 1 – P(Y 5) = 1 – 0.58918 = 0.4108

P (0) = e-5 = 0.00674

P (1) = e-5 = 0.00674

P (2) = e-5 = 0.0843

P (3) = e-5 = 0.1404

P (4) = e-5 = 0.1755

P (5) = e-5 = 0.1755

*Problem 3.170 - Tchebysheff’s Theorem*

A lumber farm produces coffins with an average width of 8 inches and standard deviation of 0.1. Using Tchebysheff’s theorem, find a lower bound for the number of coffins in a lot of 400 coffins that are expected to have a diameter between 7.5 and 8.5. (Wackerly et al., 2008)

= 7.5 and

p (7.5 < Y < 8.5)

p (| Y – 8| k(0.1))

p (8 – k(0.1) < Y < 8 + k(0.1)) 1 –

8 – k(0.1) = 7.5

8 – k(0.1) = 8.5

k = = 5

p (7.5 < Y < 8.5) 1 -

p (7.5 < Y < 8.5) 0.96

**lower bound = 0.96**

400 \* (0.96) = **384 coffins**

**Chapter 4**

*Problem 4.2 -* Continuous Random Variables

A folder contains 5 death certificates, only one of which will contain no typos. Death certificates are randomly selected, until the correct one is given to a family (incorrect death certificates are discard before another is tried). Let Y be the number of the trial on which the death certificate is correct. Find the probability function for Y (Wackerly et al., 2008).

1 - =

P (Y = 1) =

1 - =

P (Y = 2) = x =

1 -

P (Y = 3) = x x =

1 -

P (Y = 4) = x x x =

1 - = 0

P (Y = 5) = x x x x =

*Problem 4.51 – Uniform Distribution*

The cycle time for vans hauling bodies to a funeral site is uniformly distributed over the interval 50 to 70 minutes. What is the probability that the cycle time exceeds 65 minutes if it is known that the cycle time exceeded 55 minutes? (Wackerly et al., 2008)

|  |  |
| --- | --- |
| P (y > 65) =  = +  = +  =  =  = (70-65)  =  = 0.25 | P (y > 55) =  = +  = +  =  =  = (70-55)  =  = 0.75 |

= **=**

**Chapter 5**

*Example 5.1 - Discrete Bivariate*

A funeral home has three cremation chambers. Two bodies arrive at the funeral home at different times when the chambers are inactive. Each body is randomly sent to a chamber, independently of the other. Let Y1 denote the number of customers who choose chamber 1 and Y2, the number who select chamber 2. Find the joint probability function of Y1 and Y2 (Wackerly et al., 2008).

S = [{1, 1} {1, 2} {1, 3} {2, 1} {2, 2}{2, 3}{3, 1}{3, 2}{3, 3} ]

|  |  |  |  |
| --- | --- | --- | --- |
|  | y1 | | |
| y1  0  1  2 | 0 | 1 | 2 |
| 1/9  2/9  1/9 | 2/9  2/9  0 | 1/9  0  0 |

*Problem 5.22 – Multivariate*

Y1 = and Y2 =

|  |  |  |  |
| --- | --- | --- | --- |
|  | y1 | | |
| y2 | 0 | 1 | Total |
| 0  1  2 | 0.38  0.14  0.24 | 0.17  0.02  0.05 | 0.55  0.16  0.29 |
| Total | 0.76 | 0.24 | 1.00 |

1. Give the marginal probability functions for Y1 and Y2

PY2 = (y2 = 0) = 0.38 + 0.17 = **0.55**

PY2 = (y2 = 1) = 0.14 + 0.02 = **0.16**

PY2 = (y2 = 2) = 0.24 + 0.05 = **0.29**

1. Find the conditional probability functions for Y2 given Y1 = 0.

P (Y2 = 0 | Y1 = 0) = **= 0.50**

P (Y2 = 1 | Y1 = 0) = **= 0.18**

P (Y2 = 2 | Y1 = 0) = **= 0.32**

1. What is the probability that the cause of death was accidental given that there was no foul play?

P (Y1 = 0 | Y2 = 2) = **= 0.83**

P (Y1 = 1 | Y2 = 2) = **= 0.17**