Scientific Research Publishing

Open Journal of Social Sciences, 2022, 10, 462-472
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

Are Hurricanes with Female Names More Severe or Costly than Male-Named Hurricanes?

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How to cite this paper: Sommers, P.M. (2022). Are Hurricanes with Female Names More Severe or Costly than Male-Named Hurricanes? *Open Journal of Social Sciences, 10,* 462-472.
https://doi.org/10.4236/jss.2022.109028

Received: July 29, 2022
Accepted: August 27, 2022
Published: August 30, 2022

Abstract

In 2014, researchers concluded that hurricanes with female names were deadlier than male-named hurricanes. The analysis used data on hurricanes over six decades that included a period of time when *only* female names were used. In this paper, the author examines all hurricanes (with alternating female and male names) along the Atlantic Coast and the Gulf of Mexico from 1979 to 2021. The analysis shows that hurricanes with female names are no more severe (in terms of maximum wind speed or barometric pressure) than male-named hurricanes. Moreover, hurricanes with female names have not resulted in damage with higher average estimated costs than their male counterparts.

Keywords

Tropical Cyclones, Hurricane Severity, Atlantic and Gulf of Mexico Storms

1. Introduction

In 1953, the United States began using only female names for tropical storms. This practice ended in 1978 for tropical storms in the Eastern North Pacific and ended one year later for tropical storms in the Atlantic and Gulf of Mexico. Since 1979, the naming of all U.S. tropical storms has alternated between male and female names (National Hurricane Center, 2022a).

In 2014, Jung, Shavitt, Viswanathan, & Hilbe (2014) argued that hurricanes with female names were deadlier than male hurricanes. Later that same year, Malter (2014) using the same data, methodology, and variables reached the conclusion that female- and male-named hurricanes were equally deadly. One problem with the Jung et al. study was that the authors examined the death rates from U.S. hurricanes between 1950 and 2012 to show that feminine-named hurricanes cause significantly more deaths than male-named hurricanes. But, as

previously mentioned, before 1978 *only* female names were used. Neither Jung et al. nor Malter used actual measures of hurricane severity.

In this paper, comparisons are made between hurricanes from 1979 to 2021 with female and male names based on 1) average maximum wind speed, that is, the estimated maximum sustained (1-minute) surface winds to occur along the U.S. coast, measured to the nearest 5 knots (where 1 knot, abbreviated kt, equals 1.15 miles per hour); 2) average central pressure of the hurricane at landfall, measured in millibars (mb); and 3) average cost (expressed in inflation-adjusted 2022 dollars) based on estimates from National Oceanic and Atmospheric Administration's National Centers for Environmental Information that includes crop damage, individual payouts, and disaster money from the federal government to the affected states.

2. The Data

The analysis in this paper is based on 73 named hurricanes (excluding tropical storms) that made landfall along either the U.S. Atlantic Coast or the Gulf of Mexico between 1979 and 2021. All hurricanes produce sustained winds of greater than 74 mph (119 km/h). These data are shown in **Table 1** and were revised in April 2022 to include the 2021 season (National Hurricane Center, 2022b). **Table 1** includes the names; gender of the names; month and year the hurricane made landfall; the highest Saffir-Simpson U.S. category, a scale that ranges from 1 (weakest) to 5 (strongest) based on estimated maximum sustained (1-minute) surface winds produced at the coast; estimated maximum wind speed (in knots); and estimated central pressure of the hurricane at landfall (in millibars). **Table 1** includes two hurricanes from the very active 2020 Atlantic hurricane season that were named Delta and Zeta, after gender-based names were exhausted. This practice of using Greek letters to name tropical cyclones was discontinued by the World Meteorological Organization after 2020. Moreover, neither Delta nor Zeta are included here in the comparisons of the remaining 71 hurricanes with feminine or masculine names.

Not all 71 hurricanes with feminine or masculine names (between 1979 and 2021) caused at least $3.2 billion (expressed in 2022 dollars) in damage. The 34 hurricanes that did, however, are listed in **Table 2**. These data are from National Center for Environmental Information (2022). For all U.S. hurricanes, Hurricane Katrina (2005, $186.3 billion) is the costliest storm on record. Hurricane Harvey (2017, $148.8 billion) ranks second. Hurricane Maria (2017, $107.1 billion) ranks third, but is not listed among "continental United States" hurricanes in National Center for Environmental Information (2022). Hurricane Maria (a category 5 hurricane) devastated the Caribbean islands of Dominica, Saint Croix, and Puerto Rico.

3. Methodology

Two-sample *t*-tests are used to compare hurricanes with female names against

Table 1. Hurricanes with female and male names, 1979-2021.

Name	Female name?	Year	Month	Highest Saffir-Simpson U.S. category	Maximum wind (kt)	Central pressure (mb)
Bob	No	1979	July	1	NA	986
David	No	1979	September	2	NA	970
Frederic	No	1979	September	3	NA	946
Allen	No	1980	August	3	100	945
Alicia	Yes	1983	August	3	100	962
Diana	Yes	1984	September	2	95	949
Bob	No	1985	July	1	65	1003
Danny	No	1985	August	1	80	987
Elena	Yes	1985	September	3	100	959
Gloria	Yes	1985	September	3	90	942
Juan	No	1985	October	1	75	971
Kate	Yes	1985	November	2	85	967
Bonnie	Yes	1986	June	1	75	990
Charley	No	1986	August	1	65	990
Floyd	No	1987	October	1	65	993
Florence	Yes	1988	September	1	70	984
Chantal	Yes	1989	August	1	70	986
Hugo	No	1989	September	4	120	934
Jerry	No	1989	October	1	75	983
Bob	No	1991	August	2	90	962
Andrew	No	1992	August	5	145	922
Emily	Yes	1993	August	3	100	961
Erin	Yes	1995	August	2	85	973
Opal	Yes	1995	October	3	100	942
Bertha	Yes	1996	July	2	90	974
Fran	Yes	1996	September	3	100	954
Danny	No	1997	July	1	70	984
Bonnie	Yes	1998	August	2	95	964
Earl	No	1998	September	1	70	987
Georges	No	1998	September	2	90	964
Bret	No	1999	August	3	100	951
Floyd	No	1999	September	2	90	956
Irene	Yes	1999	October	2	95	964
Lili	Yes	2002	October	1	80	963
Claudette	Yes	2003	July	1	80	979
Isabel	Yes	2003	September	2	90	957

Continued

Alex	No	2004	August	1	70	972
Charley	No	2004	August	4	130	941
Gaston	No	2004	August	1	65	985
Frances	Yes	2004	September	2	90	960
Ivan	No	2004	September	3	105	946
Jeanne	Yes	2004	September	3	105	950
Cindy	Yes	2005	July	1	65	991
Dennis	No	2005	July	3	105	946
Katrina	Yes	2005	August	3	110	920
Ophelia	Yes	2005	September	1	65	982
Rita	Yes	2005	September	3	100	937
Wilma	Yes	2005	October	3	105	950
Humberto	No	2007	September	1	80	985
Dolly	Yes	2008	July	1	75	967
Gustav	No	2008	September	2	90	954
Ike	No	2008	September	2	95	950
Irene	Yes	2011	August	1	75	952
Isaac	No	2012	August	1	70	966
Sandy	Yes	2012	October	1	65	942
Arthur	No	2014	July	2	85	973
Hermine	Yes	2016	September	1	70	981
Matthew	No	2016	October	2	85	963
Harvey	No	2017	August	4	115	937
Irma	Yes	2017	September	4	115	931
Nate	No	2017	October	1	65	983
Florence	Yes	2018	September	1	80	956
Michael	No	2018	October	5	140	919
Barry	No	2019	July	1	65	993
Dorian	No	2019	September	2	85	956
Hanna	Yes	2020	July	1	80	973
Isaias	No	2020	August	1	80	986
Laura	Yes	2020	August	4	130	939
Sally	Yes	2020	September	2	95	965
Delta	*	2020	October	2	85	970
Zeta	*	2020	October	3	100	970
Ida	Yes	2021	August	4	130	931
Nicholas	No	2021	September	1	65	991

Source: National Hurricane Center, NOAA, "Continental United States Hurricane Impacts/Landfalls 1851-2021" at https://www.aoml.noaa.gov/hrd/hurdat/All_U.S._Hurricanes.html.

Table 2. Costliest continental United States hurricanes impacts/landfalls with female and male names, 1979-2021.

Name	Female name?	Year	Highest Saffir-Simpson U.S. category	Adjusted Costs (billions of 2022 dollars)
Katrina	Yes	2005	3	186.3
Harvey	No	2017	4	148.8
Sandy	Yes	2012	1	81.9
Ida	Yes	2021	4	78.7
Irma	Yes	2017	4	59.5
Andrew	No	1992	5	55.9
Ike	No	2008	2	40.2
Ivan	No	2004	3	31.6
Michael	No	2018	5	29.0
Wilma	Yes	2005	3	27.9
Florence	Yes	2018	1	27.8
Rita	Yes	2005	3	27.2
Laura	Yes	2020	4	26.0
Charley	No	2004	4	24.6
Hugo	No	1989	4	21.1
Irene	Yes	2011	1	17.4
Frances	Yes	2004	2	15.1
Matthew	No	2016	1	12.1
Jeanne	Yes	2004	3	11.5
Floyd	No	1999	2	11.3
Georges	No	1998	2	10.7
Fran	Yes	1996	3	9.3
Opal	Yes	1995	3	8.9
Alicia	Yes	1983	3	8.8
Isabel	Yes	2003	2	8.7
Sally	Yes	2020	2	8.1
Gustav	No	2008	2	8.0
Frederic	No	1979	3	6.9
Isaias	No	2020	1	5.3
Juan	No	1985	1	4.0
Dennis	No	2005	3	3.7
Isaac	No	2012	1	3.5
Elena	Yes	1985	3	3.5
Bob	No	1991	2	3.2

Source: National Hurricane Center, NOAA, "Costliest U.S. Tropical Cyclones" at https://www.ncei.noaa.gov/access/billions/dcmi.pdf.

male-named hurricanes. First, we compare average maximum wind speeds (in knots) by month (July, August, September, and October) and then by decade (1980s, 1990s, 2000s, and 2010s). Although a typical hurricane season begins in June and ends in November, only one of the named hurricanes in our sample of 71 occurred in June (Bonnie in June 1986) and one occurred in November (Kate in November 1985).

Next, we compare average maximum wind speeds across decades (the 1980s through the 2010s); four decades taken two at a time yield six comparisons. Similar comparisons are made of average barometric central pressure (in millibars). The lower the barometric pressure, the stronger the hurricane. Category 5 hurricanes, for example, have a central pressure of less than 920 millibars. Only two hurricanes in our sample, both male-named—Andrew in August 1982 and Michael in October 2018—reached Category 5 on the Saffir-Simpson scale.

We compare the average cost (in billions of 2022 dollars) of all female-named hurricanes that made landfall along the Atlantic Coast or in the Gulf of Mexico since 1979 against the average cost of all similarly defined male-named hurricanes.

All *t*-tests involve independent samples. All *t*-tests are two-tailed, that is, under the null hypothesis the two averages are equal and under the two-tailed alternative hypothesis the two averages are different. Under the two-tailed alternative, female-named hurricanes are not presumed to be stronger (or weaker) than their male counterparts. Finally, we run a chi-squared test relating the gender of the hurricane's name to the hurricane's highest Saffir-Simpson category.

4. The Results

Table 3 shows the results of all comparisons involving average maximum wind speeds and average central pressure across months and decades. Not surprisingly, maximum wind speed and minimum pressure are strongly correlated ($r = -0.8469$, $p < 0.0001$). By month, male-named hurricanes have the same or slightly lower average maximum wind speeds (slightly higher average central pressure) than their female-named counterparts. But, in no case are the differences statistically discernable (using an alpha-level of 0.05 or even 0.10). In no case are there discernable differences between female-named and masculine-named hurricanes by decade.

When average maximum wind speed (Table 4) and average central pressure (Table 5) are compared across decades for either female-named hurricanes (top half of the table) or male-named hurricanes (bottom half of the table), there are no discernable differences. For example, female-named hurricanes (as well as male-named hurricanes) were not stronger (either higher average maximum winds or lower average central pressure) in the 2010s than they were in the 1980s. If one compares female-named hurricanes in the 1980s to female-named hurricanes over the period 2010 *through* 2021, the difference in average maximum wind speed was still not significant ($p = 0.4517$), but the difference in

Table 3. Differences in average maximum wind and central pressure, hurricanes with female and male names, 1979-2021.

Average Maximum Wind (kt)			
Category	**Female name**	**Male name**	***p*-value on difference[a]**
July[b]	78.00	78.00	1.0000
August	99.44	92.50	0.5261
September	90.36	89.00	0.8301
October	89.00	84.17	0.7449
1980-1989	85.63	80.63	0.5558
1990-1999	95.00	93.57	0.8865
2000-2009	87.73	92.50	0.5828
2010-2019	81.00	88.75	0.5846
Average Central Pressure (mb)			
Category	**Female name**	**Male name**	***p*-value on difference[a]**
July	976.80	980.83	0.6851
August	954.22	962.00	0.4331
September	957.64	961.58	0.5647
October	952.20	968.67	0.2280
1980-1989	967.38	975.75	0.4447
1990-1999	961.71	960.86	0.9277
2000-2009	959.64	959.88	0.9793
2010-2019	952.40	961.25	0.4997

[a]The *p*-value reported is for a two-tailed test. That is, under the alternative hypothesis, the average for hurricanes with female names is not equal to the average for hurricanes with male names. [b]Monthly comparisons include data from 1979 through the year 2021.

Table 4. Differences in average maximum wind, hurricanes with female and male names, by decade.

Hurricanes with female names				
		Averages		***p*-value on difference[a]**
Group 1	**Group 2**	**Group 1**	**Group 2**	
1980-1989	1990-1999	85.63	93.57	0.4458
1980-1989	2000-2009	85.63	87.73	0.7625
1980-1989	2010-2019	85.63	81.00	0.6143
1990-1999	2000-2009	93.57	87.73	0.5542
1990-1999	2010-2019	93.57	81.00	0.3775
2000-2009	2010-2019	87.73	81.00	0.4801

Continued

Hurricanes with male names				
		Averages		*p*-value on difference
Group 1	Group 2	Group 1	Group 2	
1980-1989	1990-1999	80.63	93.57	0.2855
1980-1989	2000-2009	80.63	92.50	0.2656
1980-1989	2010-2019	80.63	88.75	0.4958
1990-1999	2000-2009	93.57	92.50	0.9302
1990-1999	2010-2019	93.57	88.75	0.7241
2000-2009	2010-2019	92.50	88.75	0.7582

[a]The *p*-value reported is for a two-tailed test. That is, under the alternative hypothesis, the average for hurricanes in Group 1 is not equal to the average for hurricanes in Group 2.

Table 5. Differences in average central pressure, hurricanes with female and male names, by decade.

Hurricanes with female names				
		Averages		*p*-value on difference[a]
Group 1	Group 2	Group 1	Group 2	
1980-1989	1990-1999	967.38	961.71	0.4809
1980-1989	2000-2009	967.38	959.64	0.4032
1980-1989	2010-2019	967.38	952.40	0.1751
1990-1999	2000-2009	961.71	959.64	0.8098
1990-1999	2010-2019	961.71	952.40	0.3018
2000-2009	2010-2019	959.64	952.40	0.5132
Hurricanes with male names				
		Averages		*p*-value on difference
Group 1	Group 2	Group 1	Group 2	
1980-1989	1990-1999	975.75	960.86	0.2367
1980-1989	2000-2009	975.75	959.88	0.1602
1980-1989	2010-2019	975.75	961.25	0.2501
1990-1999	2000-2009	960.86	959.88	0.9255
1990-1999	2010-2019	960.86	961.25	0.9742
2000-2009	2010-2019	959.88	961.25	0.8989

[a]The *p*-value reported is for a two-tailed test. That is, under the alternative hypothesis, the average for hurricanes in Group 1 is not equal to the average for hurricanes in Group 2.

average central pressure was slightly more noticeable ($p = 0.1028$). Adding data on male-named hurricanes in 2020 and 2021 made no difference in the comparison to average maximum wind speed in the 1980s ($p = 0.6539$) or in the com-

parison to average central pressure in the 1980s ($p = 0.4422$).

If there were data on male-named hurricanes before 1979, one could employ a difference-in-differences (DID) model. That is, one could compare the difference in intensity of female-named and male-named hurricanes before 1979 (when hurricanes were given alternating female and male names) to the difference in intensity of female-named and male-named hurricanes after 1979. But, all hurricanes before 1979 (and, in particular, between 1953 and 1979) were named after females. When male-named hurricanes from 1980 to 1989 were compared to male-named hurricanes from 2010 to 2019, there were no statistically discernable differences in either average maximum wind intensity or average barometric pressure; the same conclusion was reached when female-named hurricanes were compared. Moreover, when female-named hurricanes were compared to male-named hurricanes in the 1980s, there was no discernable difference; when female-named hurricanes were compared to their male counterparts in the 2010s, again, there was no difference. Based on the results presented in Table 3 and Table 4, a DID analysis would likely reveal that the change to giving hurricanes alternating female and male names would show that neither the hurricanes' average maximum wind speed nor average barometric pressure changed in response to the exogenous event of changing names in 1979.

When the average cost (in 2022 dollars) of female-named hurricanes is compared to that of male-named hurricanes, there is no discernable difference between the two groups. Even when Katrina, the costliest storm on record, is included, the average cost of the seventeen female-named hurricanes in Table 5 is $35.68 billion and the average cost of the seventeen male-named hurricanes is $24.7 billion, but this difference is not statistically discernable ($p = 0.4394$). When Katrina is excluded, the p-value of the two-tailed test rises to 0.8847.

Finally, a chi-squared test on a contingency table relating the gender of the hurricane's name to the highest Saffir-Simpson U.S. category (hurricanes "1" or "2" or "3, 4, 5" grouped together) yielded a test statistic of $\chi^2_{\text{calculated}} = 0.9107$ and a p-value of 0.634. In other words, female-named hurricanes are not disproportionately severe (category 3 or higher).

5. The Number of Hurricane Deaths

The National Oceanic and Atmospheric Administration (NOAA) in 2011 compiled a list of the mainland U.S. tropical cyclones causing 25 or more deaths between 1851 and 2010 (Blake, Landsea, & Gibney, 2011). A look at the list reveals that between 1953 and 1978, there were eleven hurricanes, *all* with female names: Audrey (416 deaths, 1957); Camille (256, 1969); Diane (184, 1955); Agnes (122, 1972); Hazel (95, 1954); Betsy (75, 1965); Carol (60, 1954); Donna (50, 1960); Carla (46, 1961); Hilda (38, 1964); and Connie (25, 1955). Between 1979 and 2010, there were seven hurricanes including two tropical storms on the list, three with female names [Katrina (1200, 2005); Allison, only of tropical storm intensity (412, 5001); and Fran (26, 1996)] and four with male names

[Floyd (56, 1999); Alberto, a tropical storm (30, 1994); Andrew (26, 1992); and Ivan (25, 2004)]. A comparison of the average number of deaths for the three female-named tropical cyclones (422 including Katrina, 33.5 without Katrina) to the average of the four male-named tropical cyclones (34.25) would not be very meaningful because Katrina was the third deadliest tropical cyclone on record, behind two unnamed hurricanes, one in 1928 (2500 - 3000 deaths) and the deadliest in 1900 (8000 - 12,000 deaths).

The number of deaths caused by typhoons depends not only on maximum wind speed, but a host of other factors. For examples, the number of deaths caused by typhoons will be influenced by the landfall's geographical characteristics, population density, and the extent of vulnerable housing. The number of deaths will likely be lower in areas with evacuation shelters and disaster-proof homes to withstand hurricanes. But, deaths would be higher in areas where residents are reluctant to evacuate their homes. Less intense typhoons (category 1 or 2 hurricanes) may be accompanied by torrential rains and extensive flooding that result in a large number of deaths. Although there is no gender gap between male and female names for typhoon intensity, further analysis would be needed to determine the validity of the question whether hurricane preparedness is related to the gender of a hurricane's name.

6. Concluding Remarks

A female-named hurricane is not a harbinger of doom. An analysis of the 71 named hurricanes that made landfall along the Atlantic Coast or the Gulf of Mexico between 1979 (when an alternating male-female naming system was adopted) and 2021 reveals that those with female names have neither stronger average maximum winds nor lower average central barometric pressure, by month or by decade. Female-named hurricanes are not, on average, more costly than their male counterparts. In short, female hurricanes are no more severe than male hurricanes. Hurricane severity does not depend on the gender of named hurricanes.

Acknowledgments

The author wishes to acknowledge the assistance of Maria M. Torres, Communications & Public Affairs Officer Meteorologist, NOAA Communications & External Affairs, at the National Hurricane Center in Miami, Florida who identified and provided the links to the latest available data used in this study.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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