



TRIHARD GANG

# OPTIMISING MEDICAL RESOURCE ALLOCATION FOR THE 2025 MARATHON



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# Executive Summary



Predictor  
Correlation Analysis



Physical Attributes

Marathon  
Specifications

Competitor  
Information

Distance Prediction

Medical Staff Needs



Gel Station

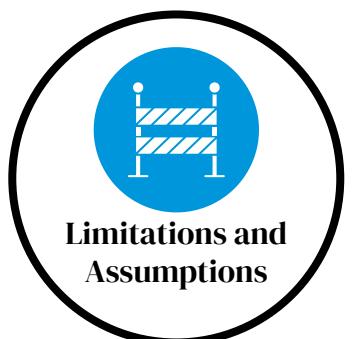
Stretching Station

Hydration Station

Financial Planning



Distance Prediction

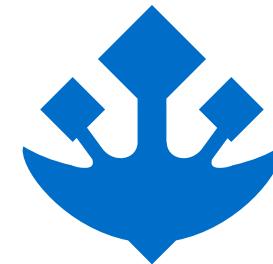


Limitations

Assumptions

# 01

## Model Injury Estimations



# Predictor Correlation Analysis



1

## Physical Attributes

As age, height and weight increases, the chance of injury similarly increases in a marathon, whilst gender has no impact on whether an individual is injured.

2

## Marathon Specifications

It was found that temperature at 10am, stretching stations, gel support and having hydration stations were correlated with the chance of attaining an injury, while all other factors had no significant impact.

3

## Competitor Information

It was noticed that all details specific to competitors such as previous injuries and marathon experience, were negatively correlated to the chance of getting injured.

# Physical Attributes

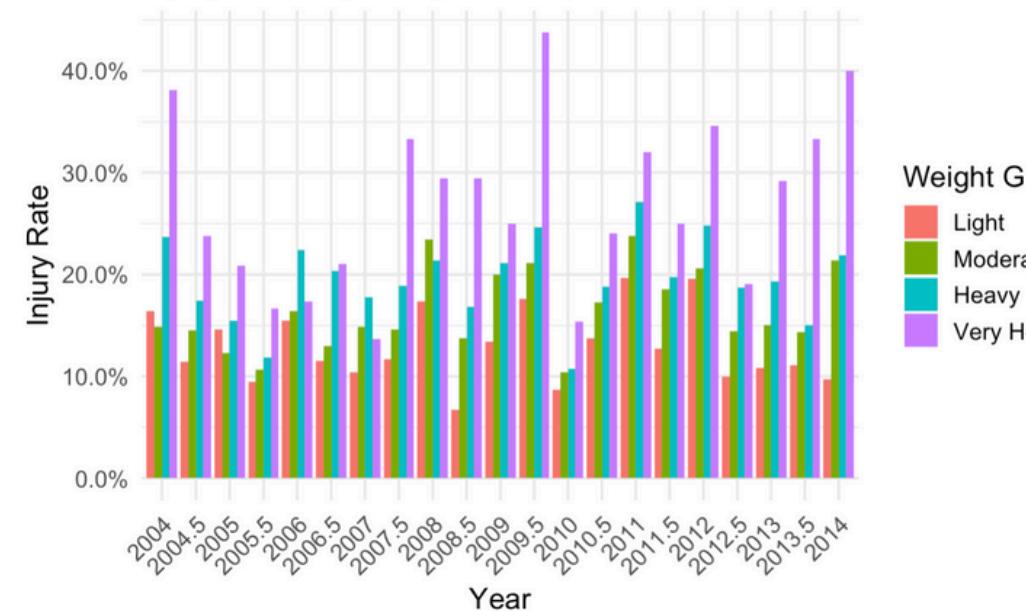


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1

## Weight

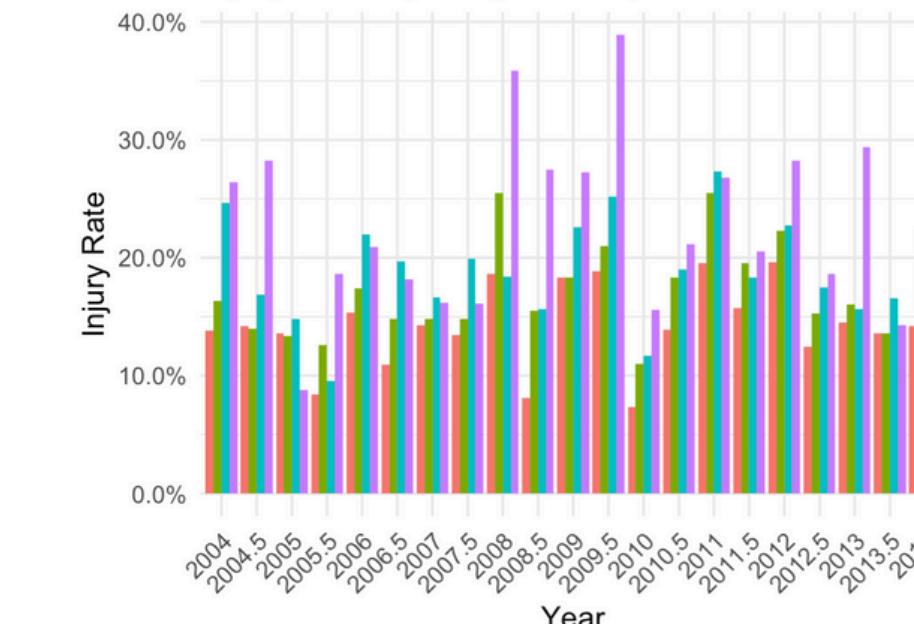
Injury Rate by Weight Group, 2004–2014



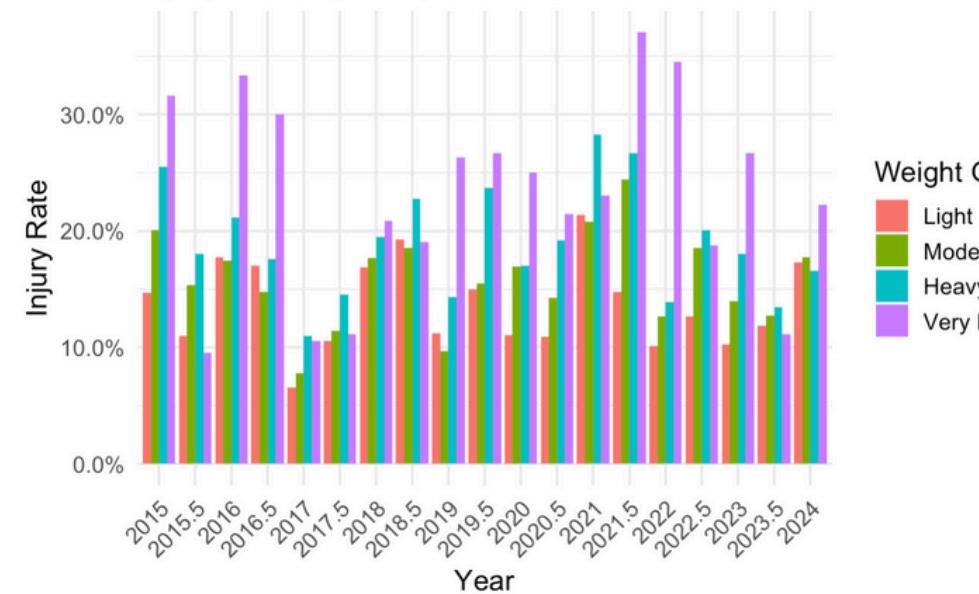
2

## Height

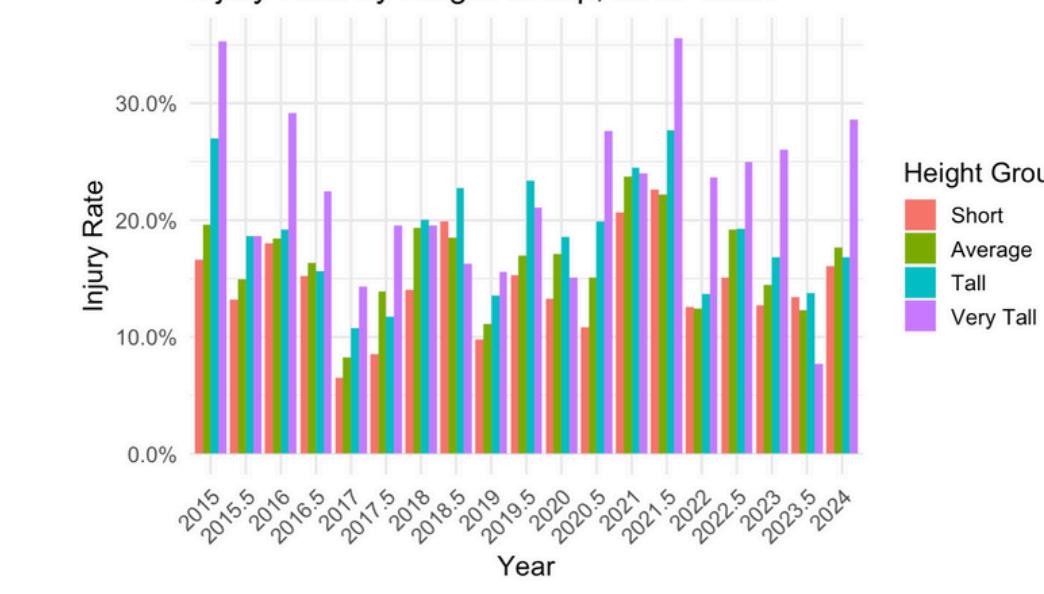
Injury Rate by Height Group, 2004–2014



Injury Rate by Weight Group, 2015–2024

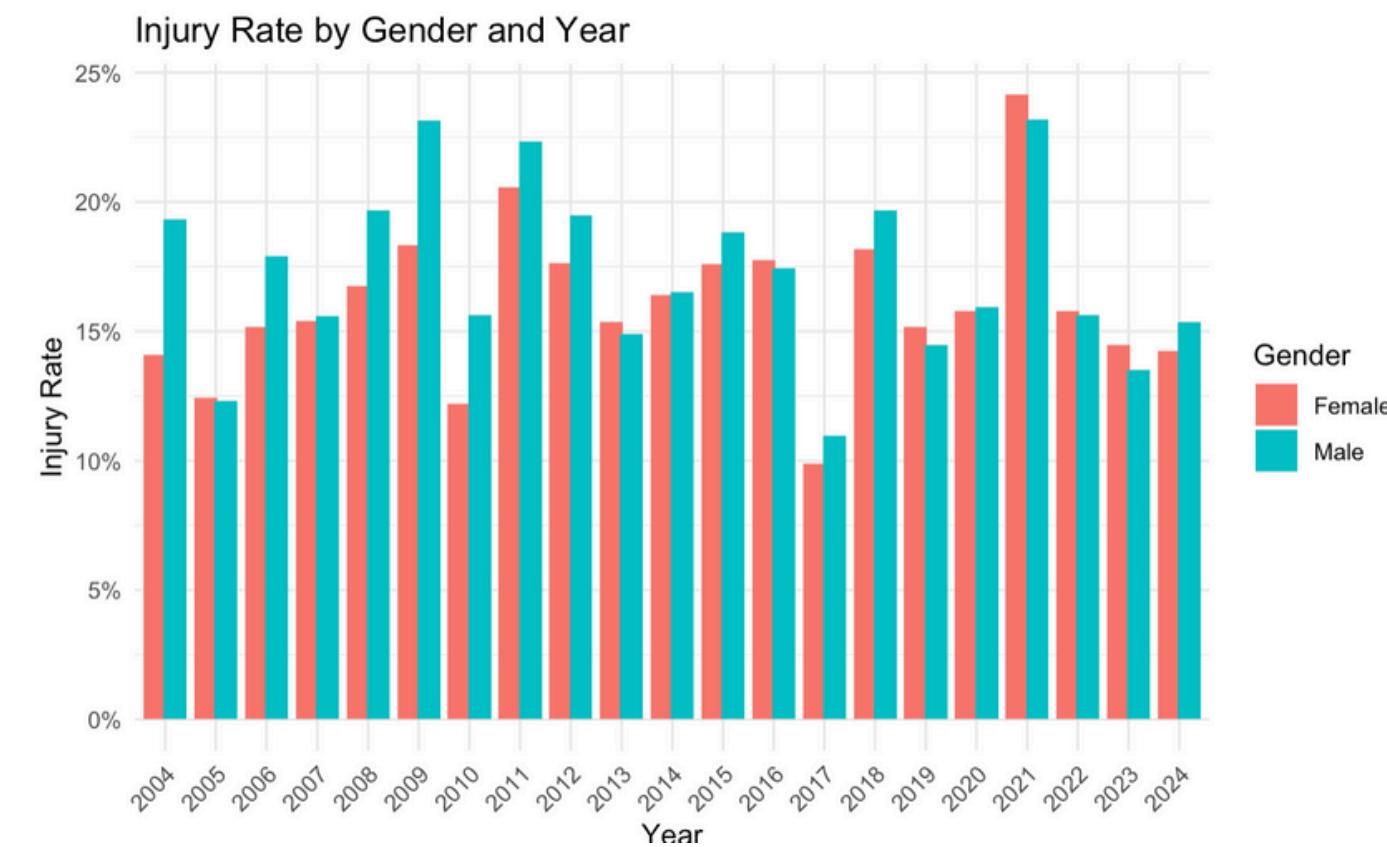


Injury Rate by Height Group, 2015–2024



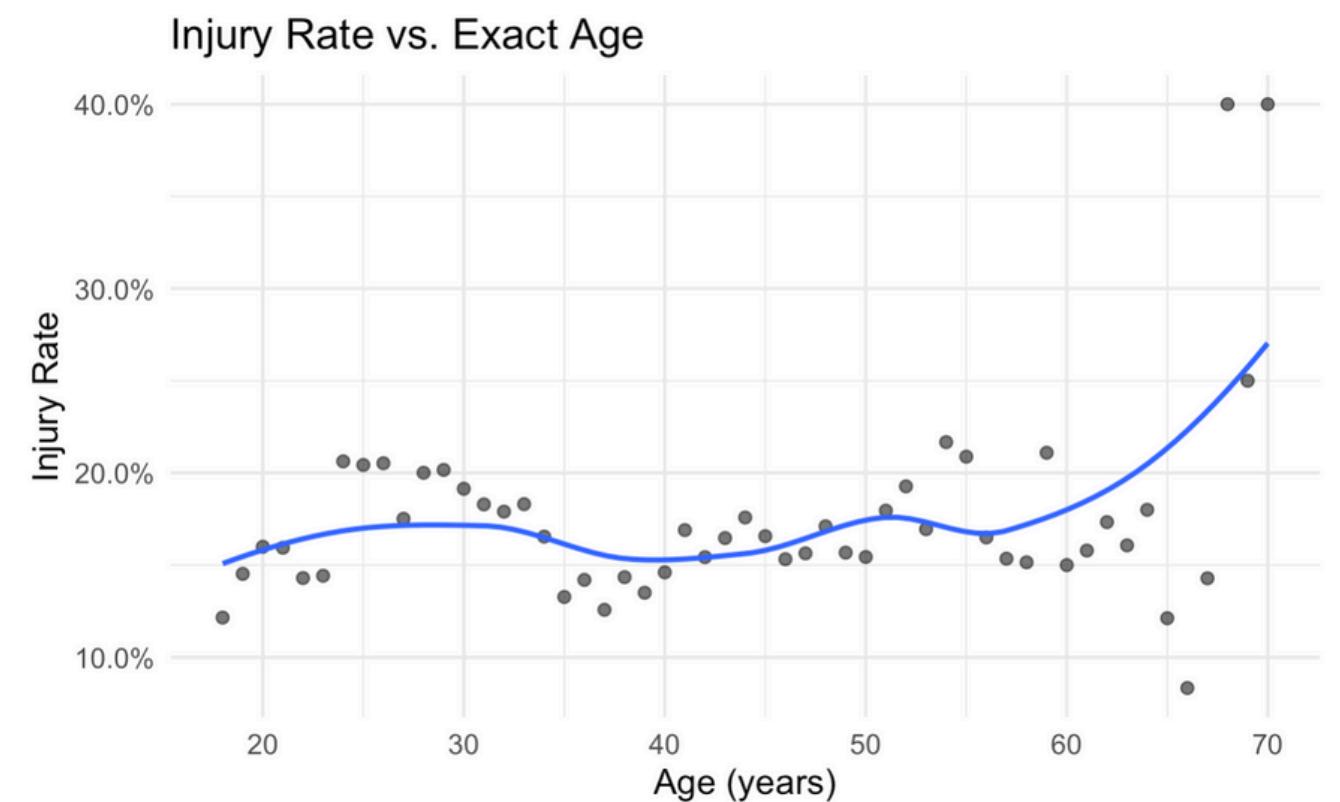
# Physical Attributes

Gender has no direct correlation with injury rate



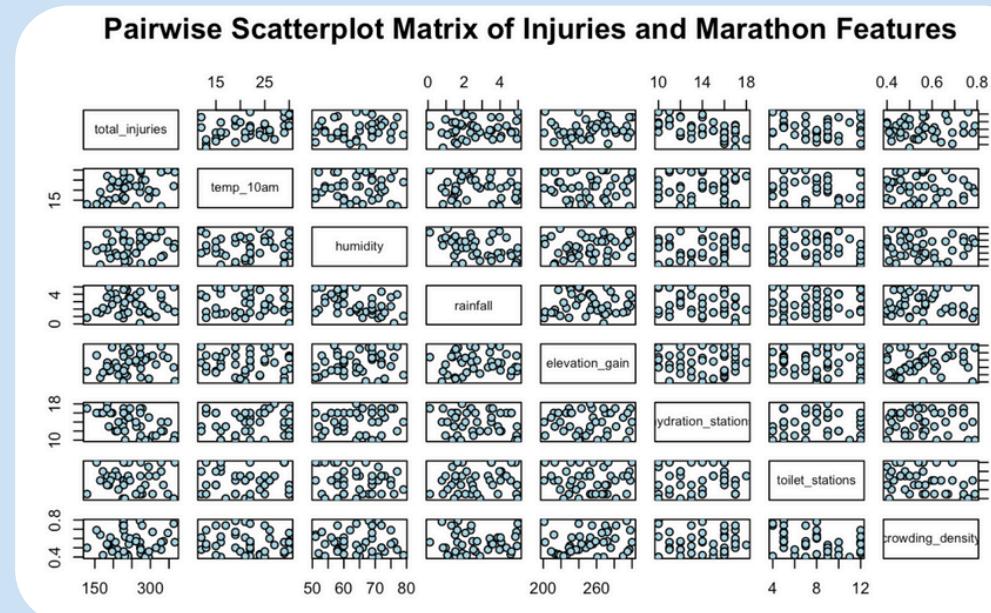
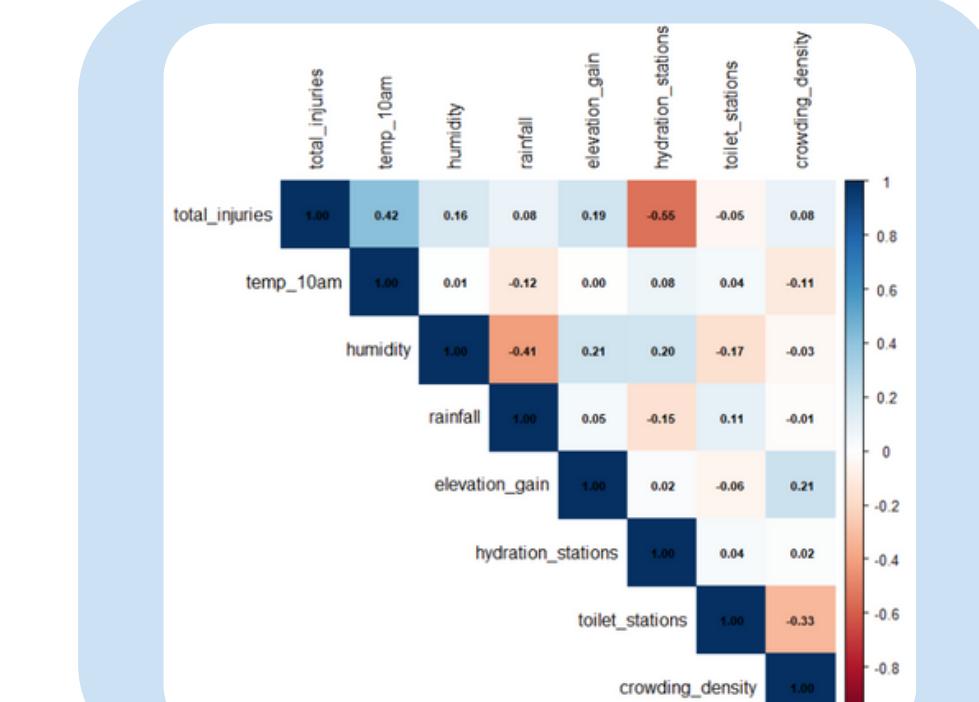
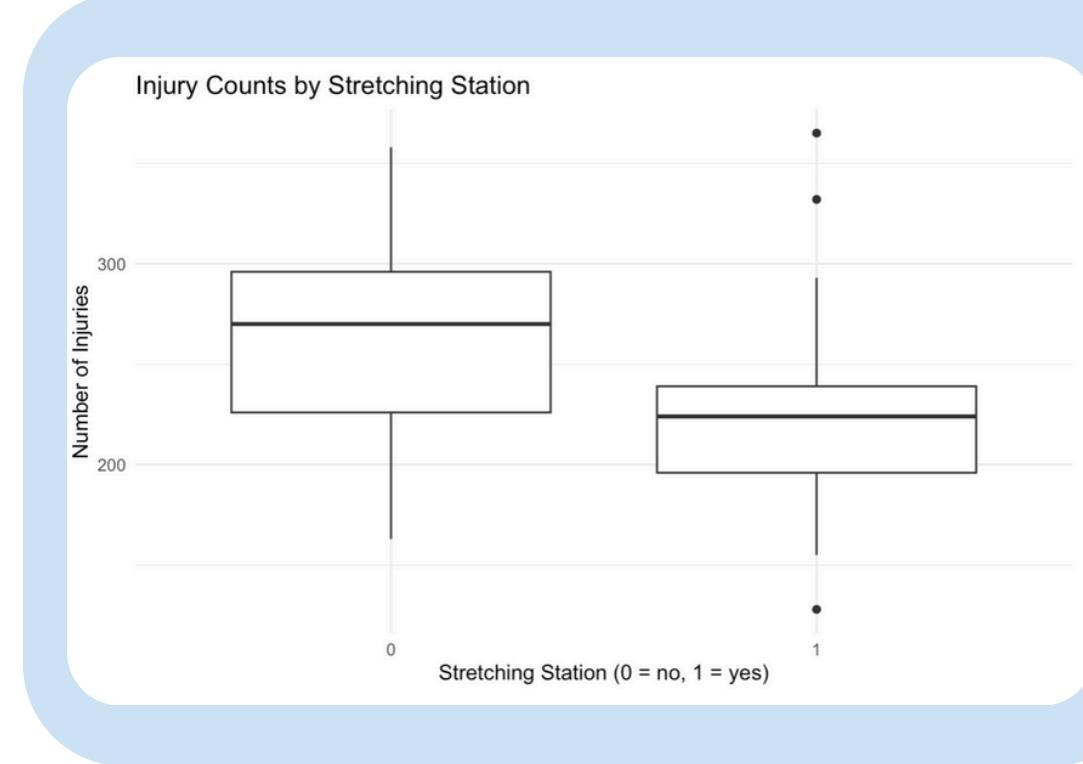
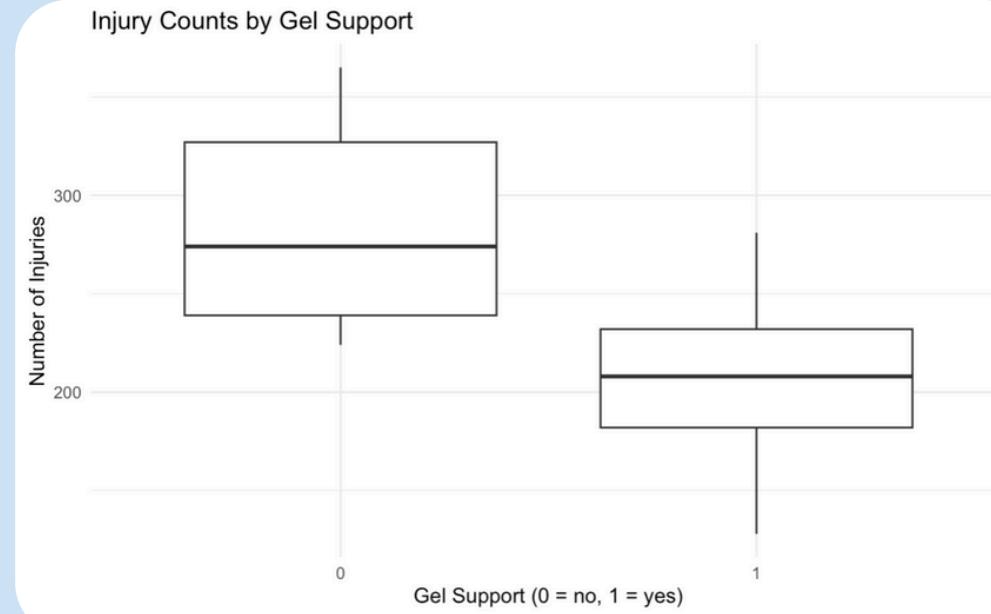
No clear correlation over years, with random years having females with more injuries and other years with males having more injuries.

Injury rate is correlated to age after the age of 55



Between the years of 20 to 55, the injury rate randomly increases and decreases, showing no clear correlation.

# Physical Attributes

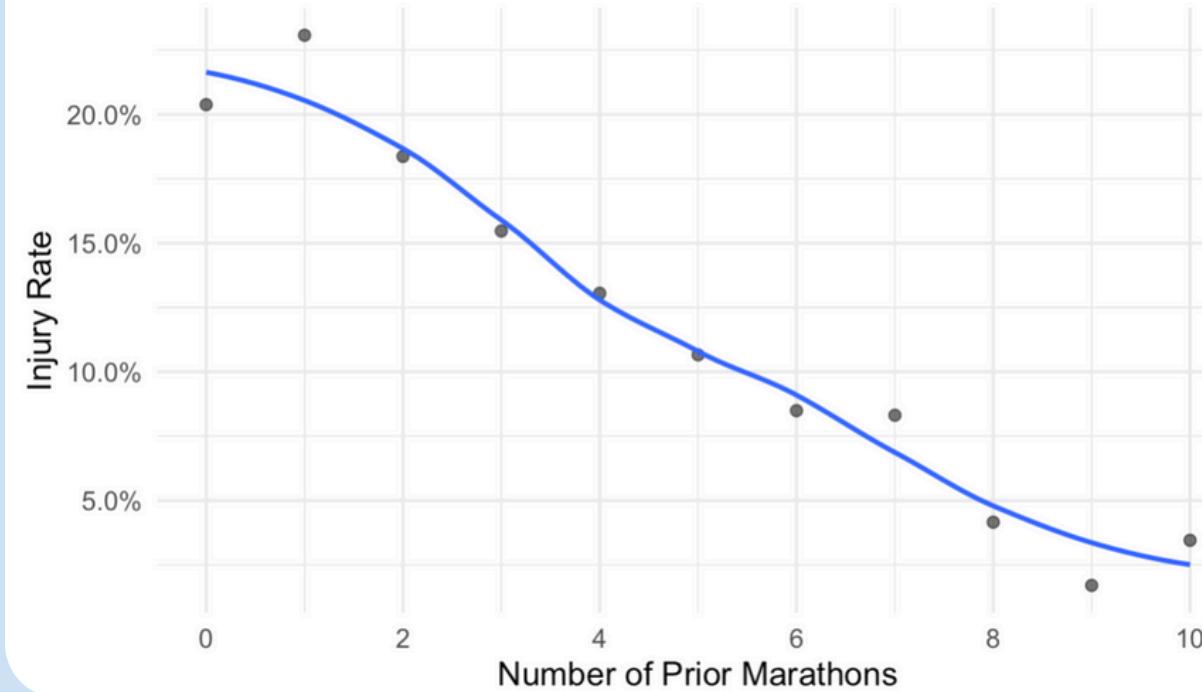


- Variation in median and non-overlapping IQR's demonstrated in the box and whisker plots, demonstrate a significant correlation to injuries
- Only temperature at 10am and hydration stations were found to explain the probability of getting injured

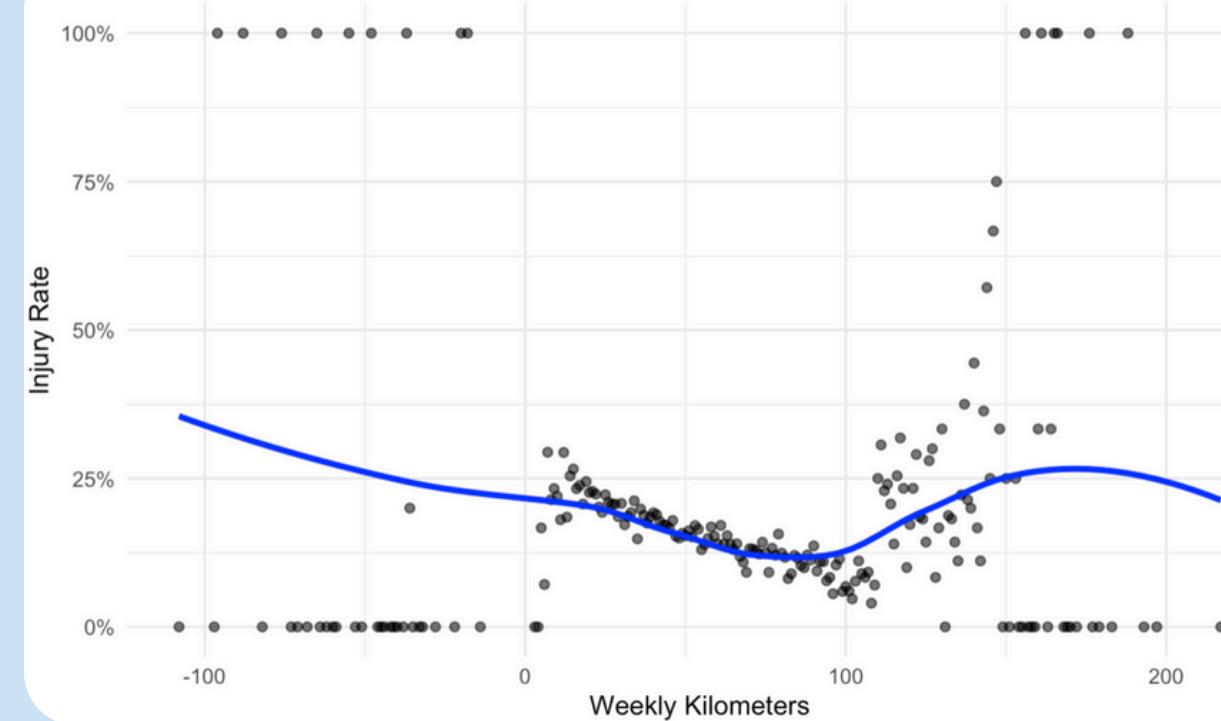


# Competitor Information

Injury Rate vs. Marathon Experience

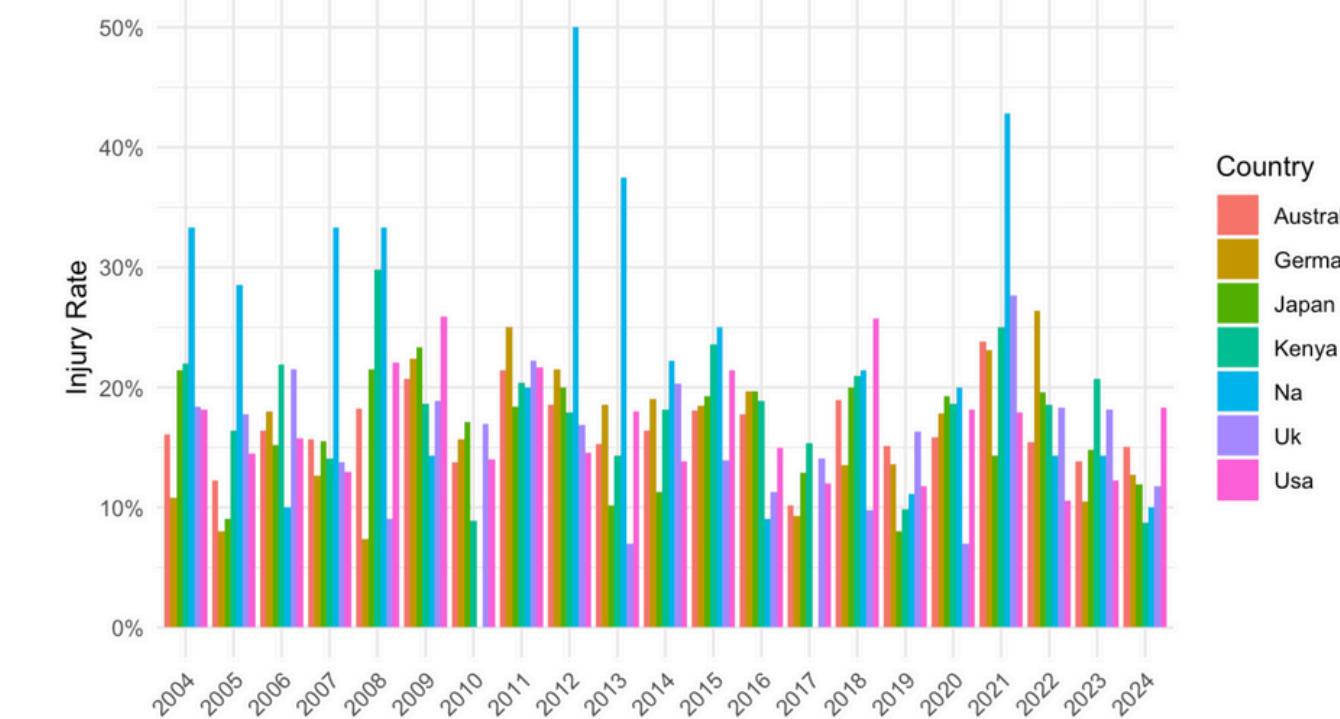


Injury Rate vs. Weekly Kilometers



- Injury rate is clearly negatively correlated with number of prior marathons.

Injury Rate by Country and Year (Cleaned)

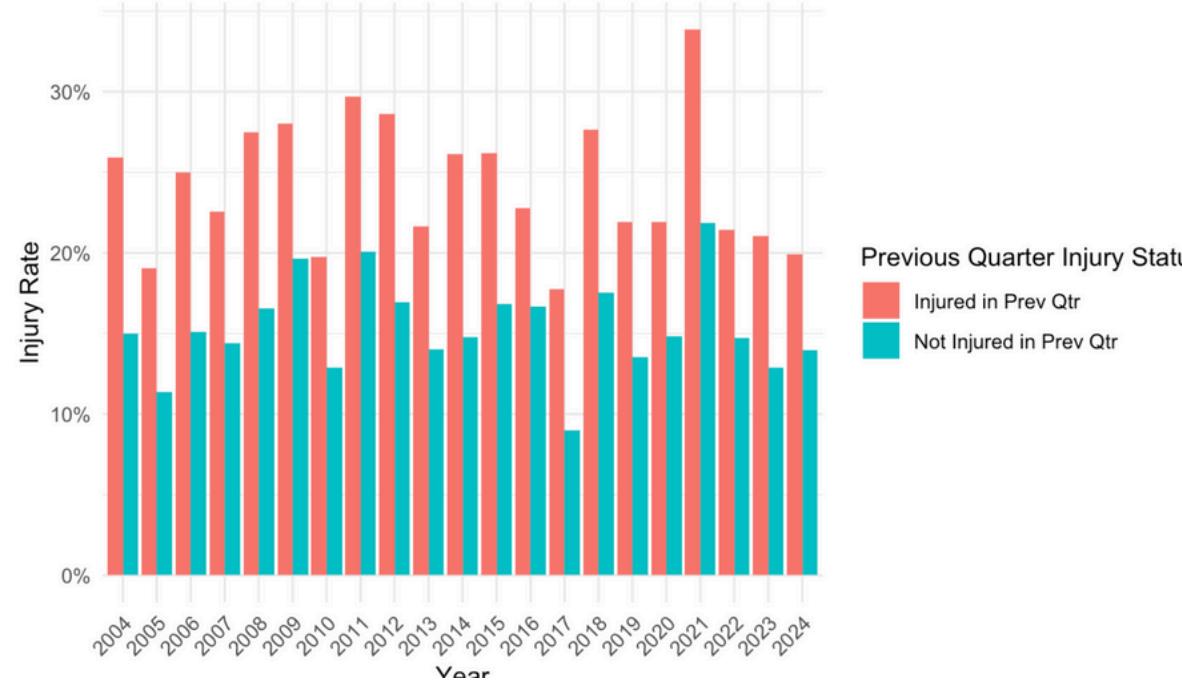


- Other variables have no discernible correlations, suggesting that weekly kilometers and country origin are insignificant variables in determining injuries

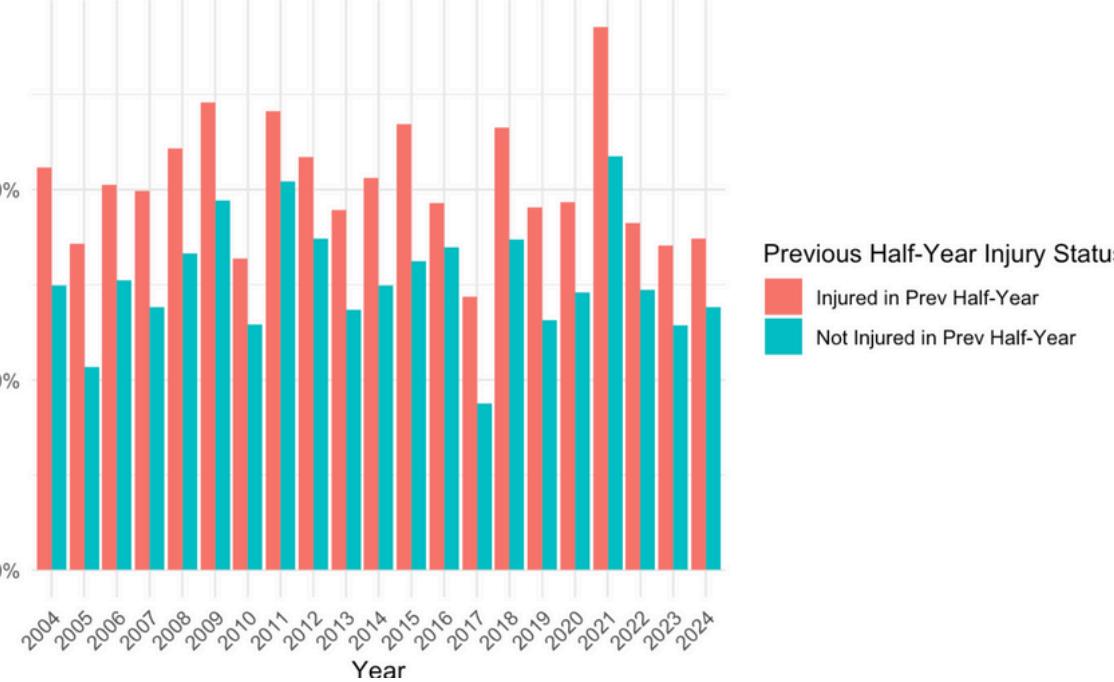


# Competitor Information

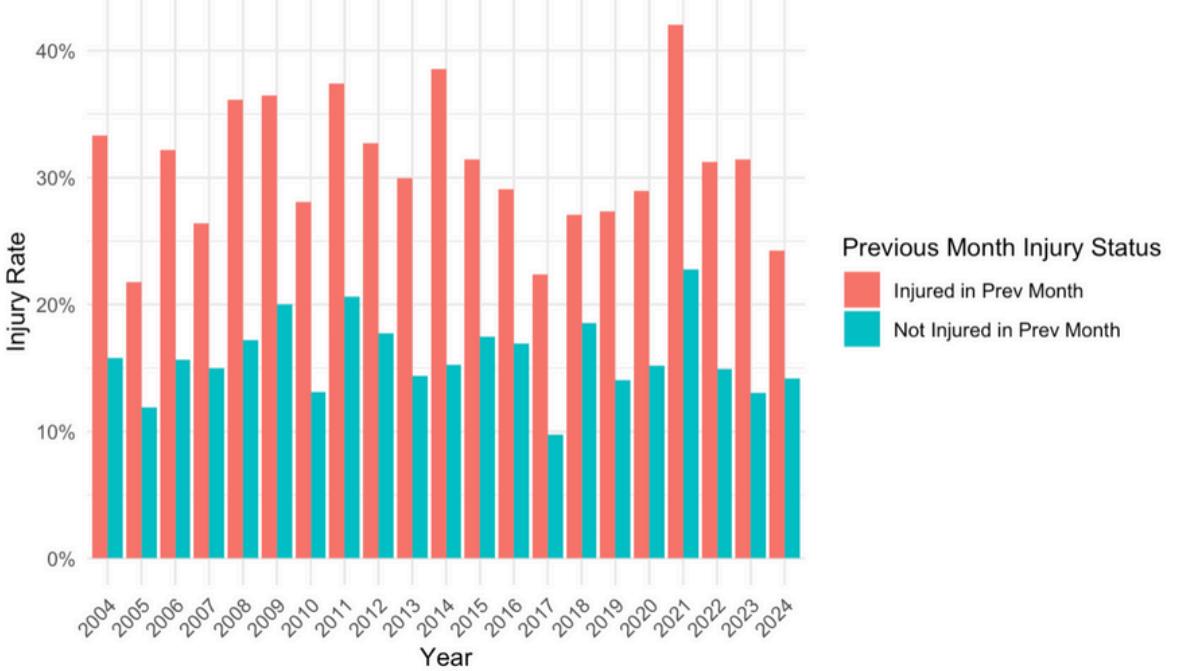
Injury Rate by Year and Previous Quarter Injury Status



Injury Rate by Year and Previous Half-Year Injury Status



Injury Rate by Year and Previous Month Injury Status



It is clear that individuals who have been previously injured are more likely to be injured during a marathon



# Logistic Regression Model

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )	
(Intercept)	-2.7153737	0.1725148	-15.740	< 2e-16	***
age_after55	0.4937443	0.0777853	6.348	2.19e-10	***
marathons_xp	-0.2075525	0.0073576	-28.209	< 2e-16	***
weight	0.0004008	0.0001991	2.013	0.0441	*
injured_prev_mth	0.5535270	0.0507761	10.901	< 2e-16	***
injured_prev_qtr	0.3236044	0.0449125	7.205	5.80e-13	***
injured_prev_hy	0.0602662	0.0335745	1.795	0.0727	.
height	0.0119711	0.0009313	12.854	< 2e-16	***
temp_10am	0.0189994	0.0019917	9.539	< 2e-16	***
hydration_stations	-0.0549068	0.0046262	-11.869	< 2e-16	***
gel_support	-0.2823620	0.0227759	-12.397	< 2e-16	***
stretching_station	-0.1157872	0.0227983	-5.079	3.80e-07	***
<hr/>					
---					
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1					

Note: Injured\_prev\_hy was included in the model, despite being deemed statistically insignificant due to the clear correlation that was found.

With this , an AIC of 54463 was achieved

# Backtesting and Final Prediction

	year	actual_injuries	predicted_injuries
1	2004	497	552.3218
2	2005	368	417.0598
3	2006	498	563.1739
4	2007	462	496.5359
5	2008	542	569.0296
6	2009	623	615.8055
7	2010	415	437.1509
8	2011	641	601.0336
9	2012	556	496.9221
10	2013	454	474.0337
11	2014	493	542.5178
12	2015	546	558.2789
13	2016	524	579.1713
14	2017	312	362.9068
15	2018	567	567.5408
16	2019	440	407.7397
17	2020	475	507.8285
18	2021	705	679.8889
19	2022	471	509.5025
20	2023	416	425.8283
21	2024	442	446.9966

Backtest results indicate 83% accuracy.  
The model provided a final prediction of 612 total injuries.

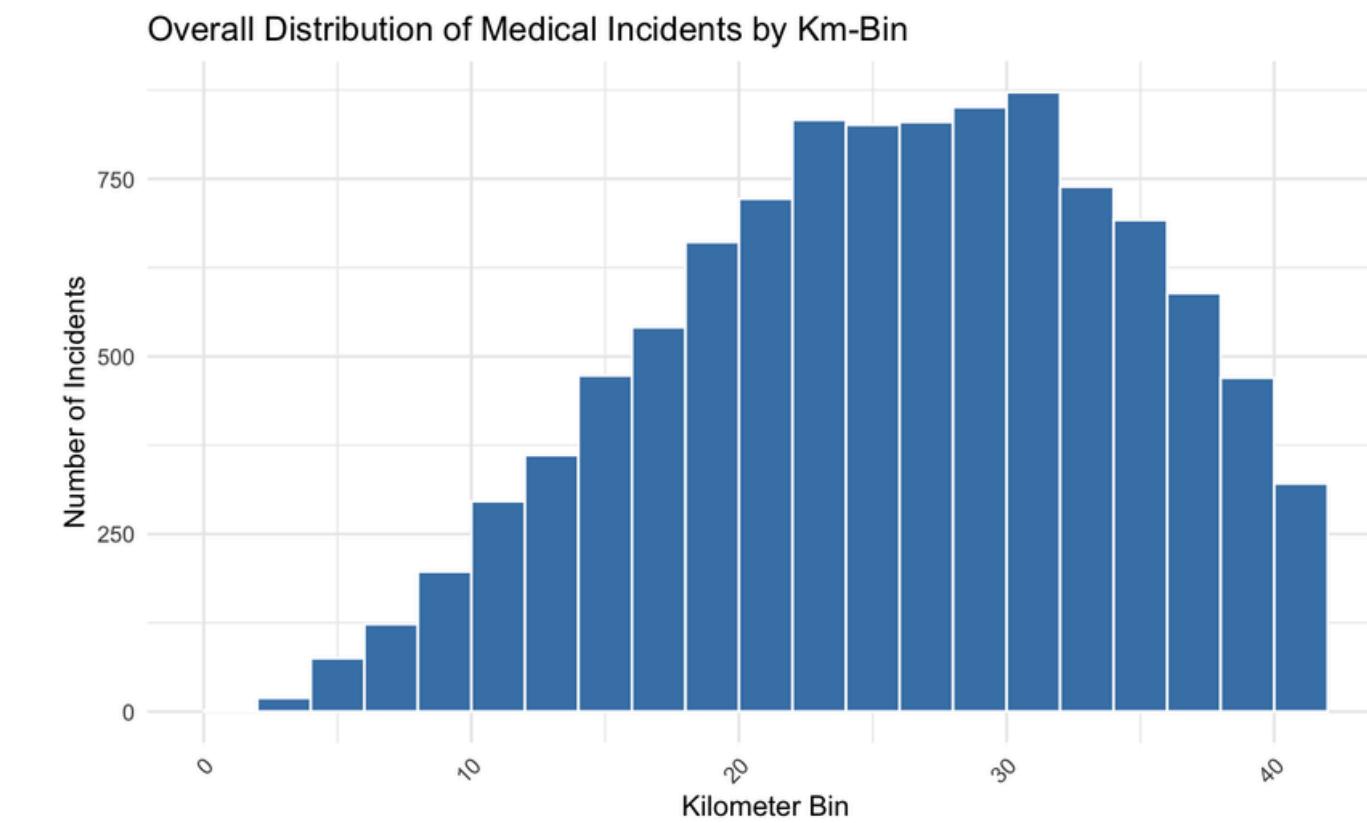
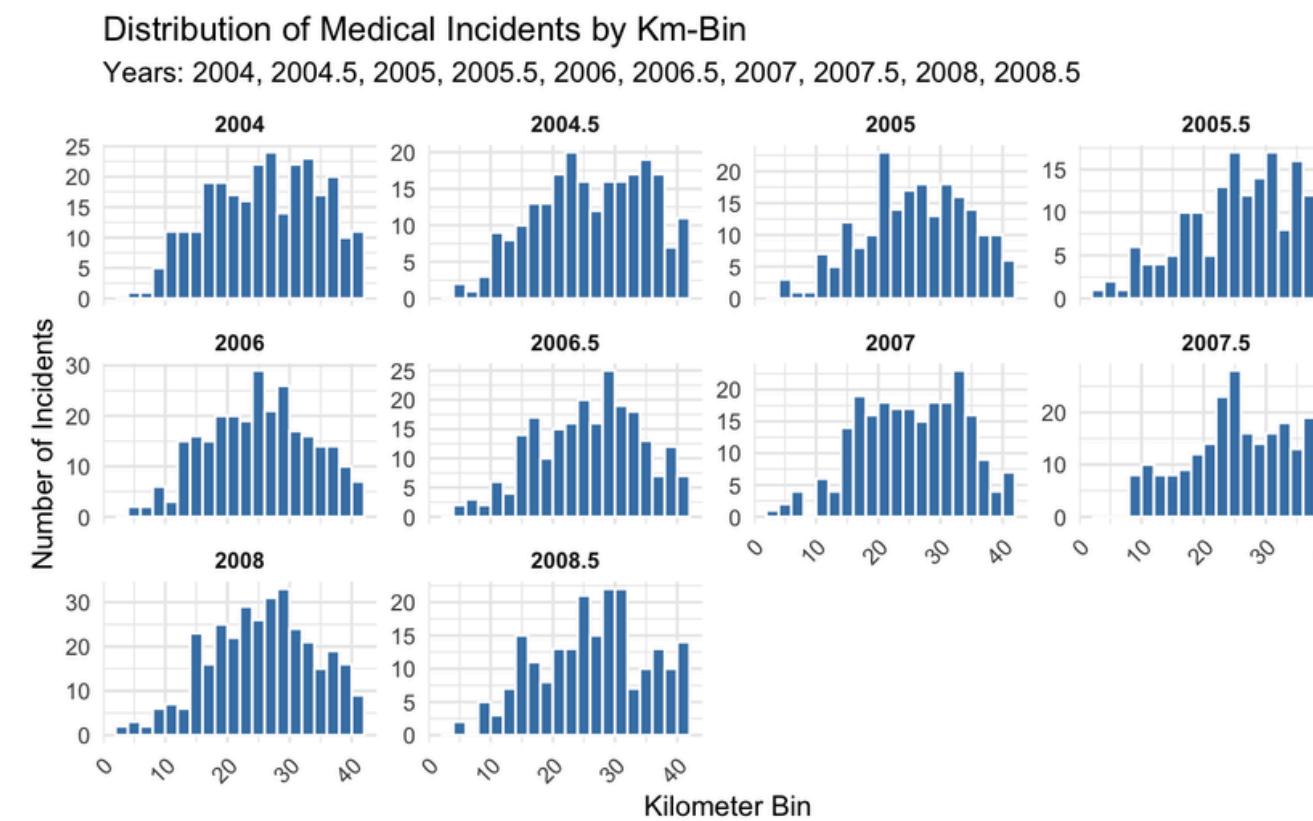
# 02

## Distance of Injury Estimates



# Distance Prediction

Aim: To calculate when in the race injuries will occur

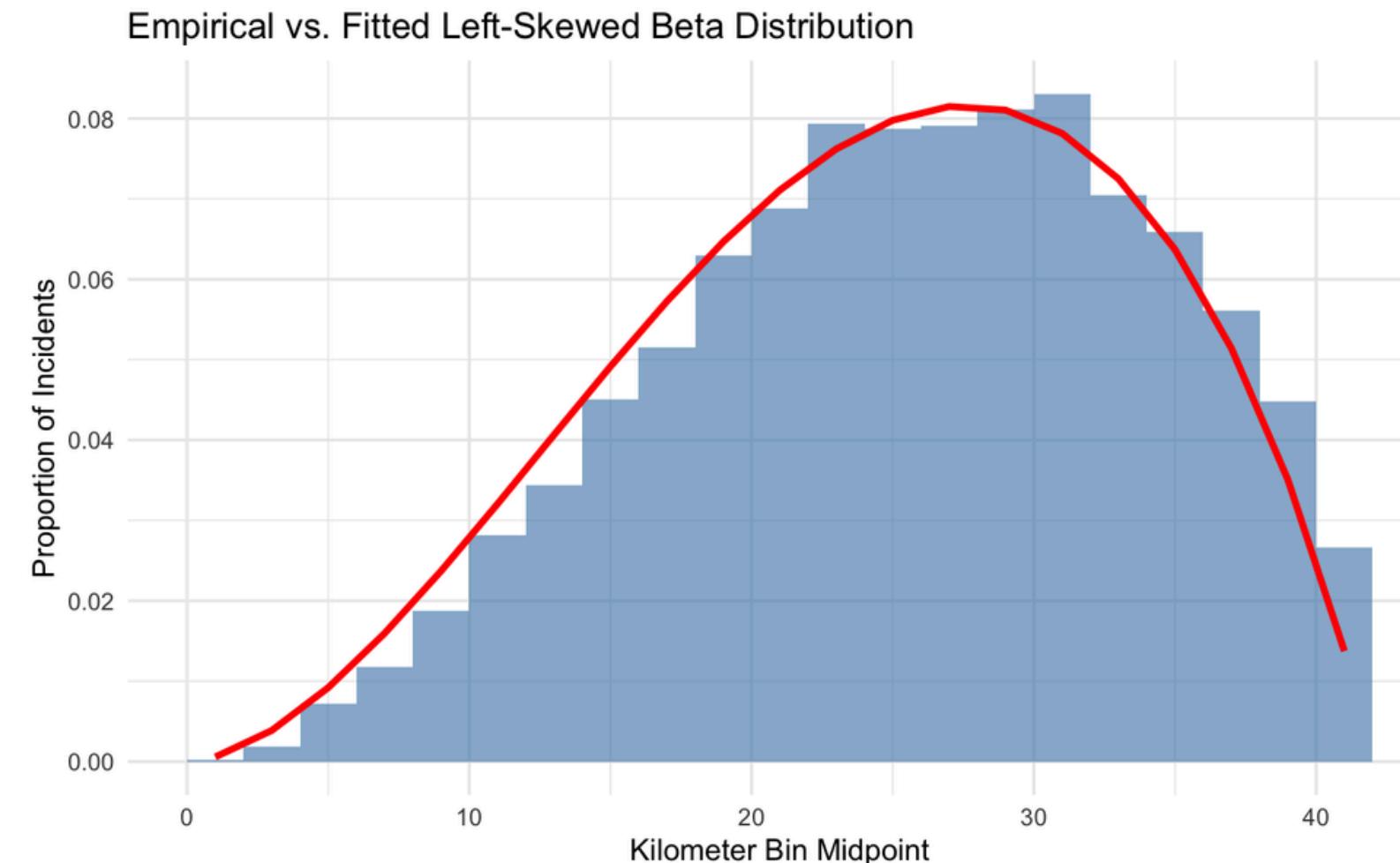


To predict the distance that an individual who was predicted to be injured would make before requiring medical attention, we analysed the distribution of past injury distances.



# Distance Prediction

Aim: To calculate when in the race injuries will occur



From the overall histogram, a beta distribution of proportions was fit, predicting the proportion of incidents at each distance.

# Medical Staff Needs

*Aim: To predict the medical staff required at each medical tent in the marathon*

	bin	prop	expected_injuries	Number of Medical Staff
1	0-2 km	0.0006	0.3	2
2	2-4 km	0.0039	2.4	2
3	4-6 km	0.0092	5.6	2
4	6-8 km	0.0160	9.8	2
5	8-10 km	0.0237	14.5	3
6	10-12 km	0.0321	19.6	4
7	12-14 km	0.0406	24.9	5
8	14-16 km	0.0492	30.1	7
9	16-18 km	0.0573	35.0	7
10	18-20 km	0.0647	39.6	8
11	20-22 km	0.0711	43.5	9
12	22-24 km	0.0762	46.6	10
13	24-26 km	0.0798	48.8	10
14	26-28 km	0.0815	49.9	10
15	28-30 km	0.0811	49.6	10
16	30-32 km	0.0782	47.8	10
17	32-34 km	0.0725	44.4	9
18	34-36 km	0.0637	39.0	8
19	36-38 km	0.0514	31.5	7
20	38-40 km	0.0351	21.5	5
21	40-42 km	0.0137	8.4	2

From the set requirements, and the fit beta distribution, the following number of medical staff needs was formed.

03

How can Sydney  
Marathon reduce the  
number of injuries

# Key Factors to focus on

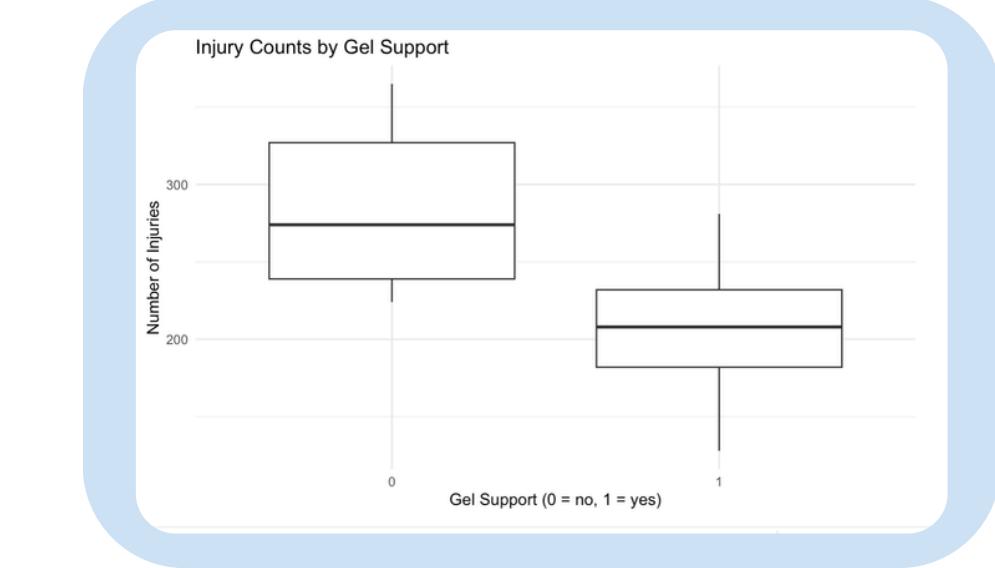


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## Gel Station

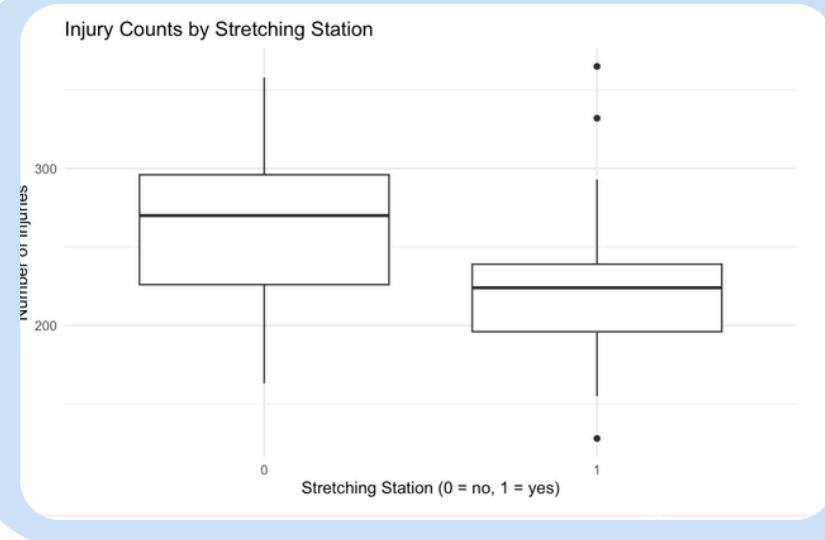
1

Provides quick energy to prevent fatigue, muscle breakdown, and loss of coordination caused by depleted glycogen levels.



## Stretching Station

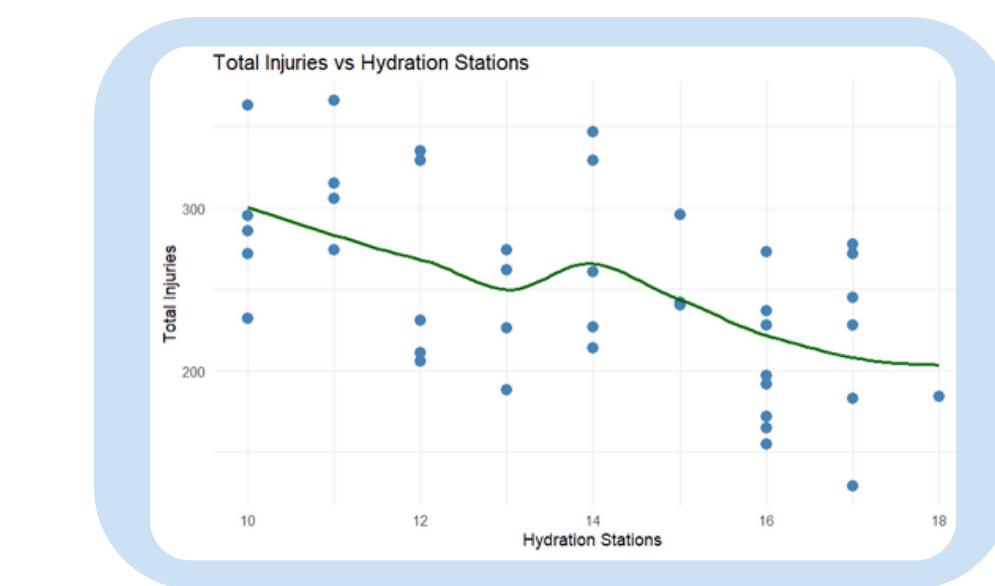
2



## Hydration Station

3

Helps maintain fluid balance, preventing dehydration-related issues like cramps, heat exhaustion, and impaired performance.



# GEL STATION

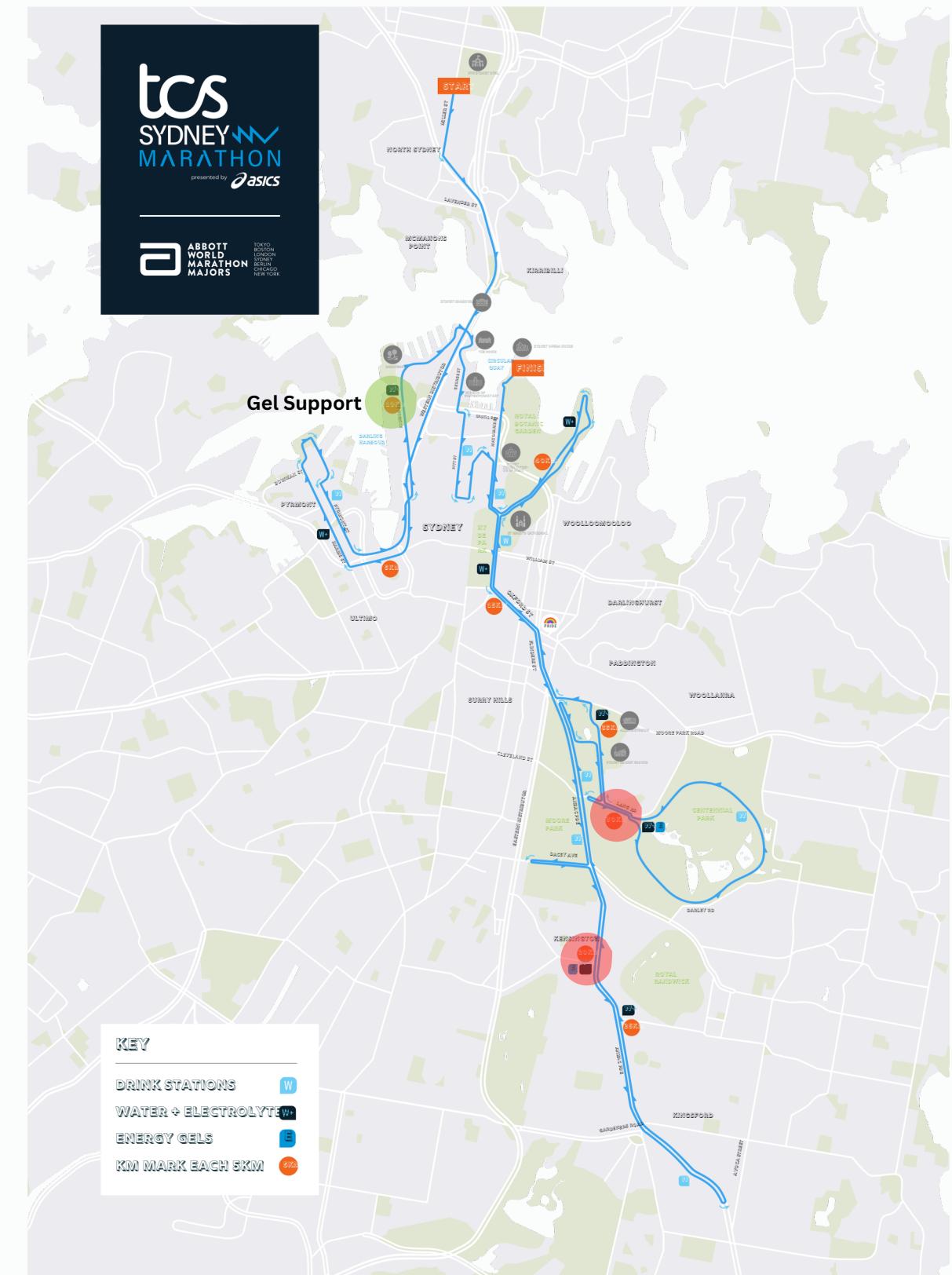
- Already 2 stations at 20km and 30km
- Beta coefficient = -0.282 (26.42% decrease)
- Effect of adding another at 10km

gel\_support      -0.2823620    0.0227759    -12.397    < 2e-16 \*\*\*

bin	prop	expected_injuries	Number of Medical Staff	expected_injuries_aftergel	Number of Medical Staff_aftergel
1	0.0006	0.3	2	0.3000	2
2	0.0039	2.4	2	2.4000	2
3	0.0092	5.6	2	5.6000	2
4	0.0160	9.8	2	9.8000	2
5	0.0237	14.5	3	14.5000	3
6	0.0321	19.6	4	14.4256	3
7	0.0406	24.9	5	18.3264	4
8	0.0492	30.1	7	22.1536	5
9	0.0573	35.0	7	25.7600	6
10	0.0647	39.6	8	29.1456	6
11	0.0711	43.5	9	43.5000	9
12	0.0762	46.6	10	46.6000	10
13	0.0798	48.8	10	48.8000	10
14	0.0815	49.9	10	49.9000	10
15	0.0811	49.6	10	49.6000	10
16	0.0782	47.8	10	47.8000	10
17	0.0725	44.4	9	44.4000	9
18	0.0637	39.0	8	39.0000	8
19	0.0514	31.5	7	31.5000	7
20	0.0351	21.5	5	21.5000	5
21	0.0137	8.4	2	8.4000	2

**Injuries Decrease: 612 - 572 = 40 (6.54%)**

**Medical Staff Decrease: 132 - 125 = 7 (5.30%)**



# GEL STATION: PRACTICAL CONSIDERATIONS



**Price: \$3.25 per pouch**

**34.77% price  
decrease**



**Price: \$2.12 per  
serving**

Product Name	Carbs / Gel (grams)	Cost / Gel	Cost / 100 Grams	Gels / Carton	Pack Cost	Cost / Carb	Carbs / Dollar	Cost / 50 Grams	Cost / 90 Grams	Cost / 120 Grams	# Gels To Hit 120g
Carbs Fuel	50	\$2.00	\$4.00								
Hammer Nutrition Gel BULK Jug	572	\$24.95	\$4.36	1	\$24.95	\$0.044	22.93	\$2.18	\$3.93	\$5.23	0.21
SIS Isotonic Gels (The Feed \$1 per Sale)	22	\$1.00	\$4.55	6	\$6.00	\$0.045	22.00	\$2.27	\$4.09	\$5.45	5.45
GU Original BULK Pouch	330	\$15.00	\$4.55	1	\$15.00	\$0.045	22.00	\$2.27	\$4.09	\$5.45	0.36
Precision Gel 90	90	\$5.33	\$5.92	10	\$53.31	\$0.059	16.88	\$2.96	\$5.33	\$7.11	1.33
Precision Gel BULK 300 Pouch	300	\$17.80	\$5.93	5	\$88.99	\$0.059	16.86	\$2.97	\$5.34	\$7.12	0.40
Crank E-gel	37	\$2.25	\$6.08	24	\$54.00	\$0.061	16.44	\$3.04	\$5.47	\$7.30	3.24
SIS Beta Fuel Gels	40	\$2.50	\$6.25	6	\$14.99	\$0.062	16.01	\$3.12	\$5.62	\$7.50	3.00
Hammer Nutrition Gel	22	\$1.46	\$6.62	24	\$34.95	\$0.066	15.11	\$3.31	\$5.96	\$7.94	5.45
Clif Shot Energy Gel	25	\$1.67	\$6.67	24	\$39.99	\$0.067	15.00	\$3.33	\$6.00	\$8.00	4.80
Honey Stinger Gels	24	\$1.67	\$6.94	24	\$39.99	\$0.069	14.40	\$3.47	\$6.25	\$8.33	5.00
Untapped	26	\$1.85	\$7.11	20	\$36.95	\$0.071	14.07	\$3.55	\$6.40	\$8.53	4.62
GU Original	22	\$1.58	\$7.20	24	\$37.99	\$0.072	13.90	\$3.60	\$6.48	\$8.63	5.45
Amacx Turbo Gel	40	\$3.00	\$7.50	12	\$36.00	\$0.075	13.33	\$3.75	\$6.75	\$9.00	3.00
Styrkr Gel50	50	\$3.75	\$7.50	12	\$44.99	\$0.075	13.33	\$3.75	\$6.75	\$9.00	2.40
SIS Isotonic Gels	22	\$1.67	\$7.57	30	\$49.99	\$0.076	13.20	\$3.79	\$6.82	\$9.09	5.45
Charge! Gel Drink	45	\$3.50	\$7.77	6	\$20.99	\$0.078	12.86	\$3.89	\$7.00	\$9.33	2.67
Precision Gel 30	30	\$2.33	\$7.78	30	\$69.99	\$0.078	12.86	\$3.89	\$7.00	\$9.33	4.00
6D Ultra Energy Gel	45	\$3.50	\$7.78	6	\$21.00	\$0.078	12.86	\$3.89	\$7.00	\$9.33	2.67
Enervit C2:1PRO Carbo Gel	40	\$3.29	\$8.23	24	\$79.00	\$0.082	12.15	\$4.11	\$7.41	\$9.88	3.00
First Endurance Liquid Shot	30	\$2.50	\$8.33	24	\$59.95	\$0.083	12.01	\$4.16	\$7.49	\$9.99	4.00
Santa Madre Unusual 60g Gel	60	\$5.00	\$8.33	12	\$59.99	\$0.083	12.00	\$4.17	\$7.50	\$10.00	2.00
Victus Energy Gel	45	\$3.75	\$8.33	12	\$45.00	\$0.083	12.00	\$4.17	\$7.50	\$10.00	2.67
Amacx Drink Gel	30	\$2.58	\$8.61	12	\$31.00	\$0.086	11.61	\$4.31	\$7.75	\$10.33	4.00
TORQ Energy Gel	29	\$2.50	\$8.62	15	\$37.50	\$0.086	11.60	\$4.31	\$7.76	\$10.34	4.14
Velaforte Energy Gel	22	\$1.92	\$8.71	24	\$45.97	\$0.087	11.49	\$4.35	\$7.84	\$10.45	5.45
PowerBar PowerGel	26	\$2.29	\$8.80	24	\$54.89	\$0.088	11.37	\$4.40	\$7.92	\$10.56	4.62
Endurance Tap	50	\$4.42	\$8.83	12	\$52.99	\$0.088	11.32	\$4.42	\$7.95	\$10.60	2.40
Santa Madre Unusual 45g Gel	45	\$4.17	\$9.26	12	\$49.99	\$0.093	10.80	\$4.63	\$8.33	\$11.11	2.67
Santa Madre Unusual 30g Gel	30	\$3.00	\$10.00	30	\$89.99	\$0.100	10.00	\$5.00	\$9.00	\$12.00	4.00
6D Energy Gel	30	\$3.00	\$10.00	6	\$18.00	\$0.100	10.00	\$5.00	\$9.00	\$12.00	4.00
Enervit C2:1PRO Carbo Chewable Gel	30	\$3.00	\$10.00	20	\$60.00	\$0.100	10.00	\$5.00	\$9.00	\$12.00	4.00
OTE Energy Gel	20.5	\$2.12	\$10.33	20	\$42.35	\$0.103	9.68	\$5.16	\$9.30	\$12.40	5.85
Huma Energy Gel	22	\$2.41	\$10.98	24	\$57.95	\$0.110	9.11	\$5.49	\$9.88	\$13.17	5.45
Enervit Liquid Gel	30	\$3.33	\$11.11	12	\$39.99	\$0.111	9.00	\$5.55	\$10.00	\$13.33	4.00
Styrkr Gel30	30	\$3.33	\$11.11	12	\$39.99	\$0.111	9.00	\$5.55	\$10.00	\$13.33	4.00
PowerBar PowerGel Hydro	25	\$2.91	\$11.63	24	\$69.79	\$0.116	8.60	\$5.82	\$10.47	\$13.96	4.80
NeverSecond C30 Energy Gel	30	\$3.50	\$11.67	12	\$42.00	\$0.117	8.57	\$5.83	\$10.50	\$14.00	4.00
GU Roctane	21	\$2.60	\$12.38	24	\$62.40	\$0.124	8.08	\$6.19	\$11.14	\$14.86	5.71
BPN Go Gel	24	\$3.00	\$12.50	10	\$29.99	\$0.125	8.00	\$6.25	\$11.25	\$15.00	5.00
Rawvelo Energy Gel	20	\$2.50	\$12.50	12	\$29.99	\$0.125	8.00	\$6.25	\$11.25	\$15.00	6.00
Maurten Gel 160	40	\$5.00	\$12.50	10	\$50.00	\$0.125	8.00	\$6.25	\$11.25	\$15.00	3.00
Nääk Ultra Energy Gel (Salted Maple)	27	\$3.50	\$12.96	12	\$42.00	\$0.130	7.71	\$6.48	\$11.67	\$15.56	4.44
Veloforte Gels	22	\$2.97	\$13.51	18	\$53.49	\$0.135	7.40	\$6.75	\$12.16	\$16.21	5.45
Maurten Gel 100	25	\$3.60	\$14.40	12	\$43.20	\$0.144	6.94	\$7.20	\$12.96	\$17.28	4.80
Spring Energy Gel (Awesome Sauce)	28	\$4.10	\$14.64	20	\$82.00	\$0.146	6.83	\$7.32	\$13.18	\$17.57	4.29
6D ISO Energy Gel	20	\$3.00	\$15.00	6	\$18.00	\$0.150	6.67	\$7.50	\$13.50	\$18.00	6.00
NeverSecond Ice Gel	30	\$4.75	\$15.83	8	\$38.00	\$0.158	6.32	\$7.92	\$14.25	\$19.00	4.00
UCAN Edge Gel	19	\$3.16	\$16.64	12	\$37.95	\$0.166	6.01	\$8.32	\$14.98	\$19.97	6.32

# STRETCHING STATION

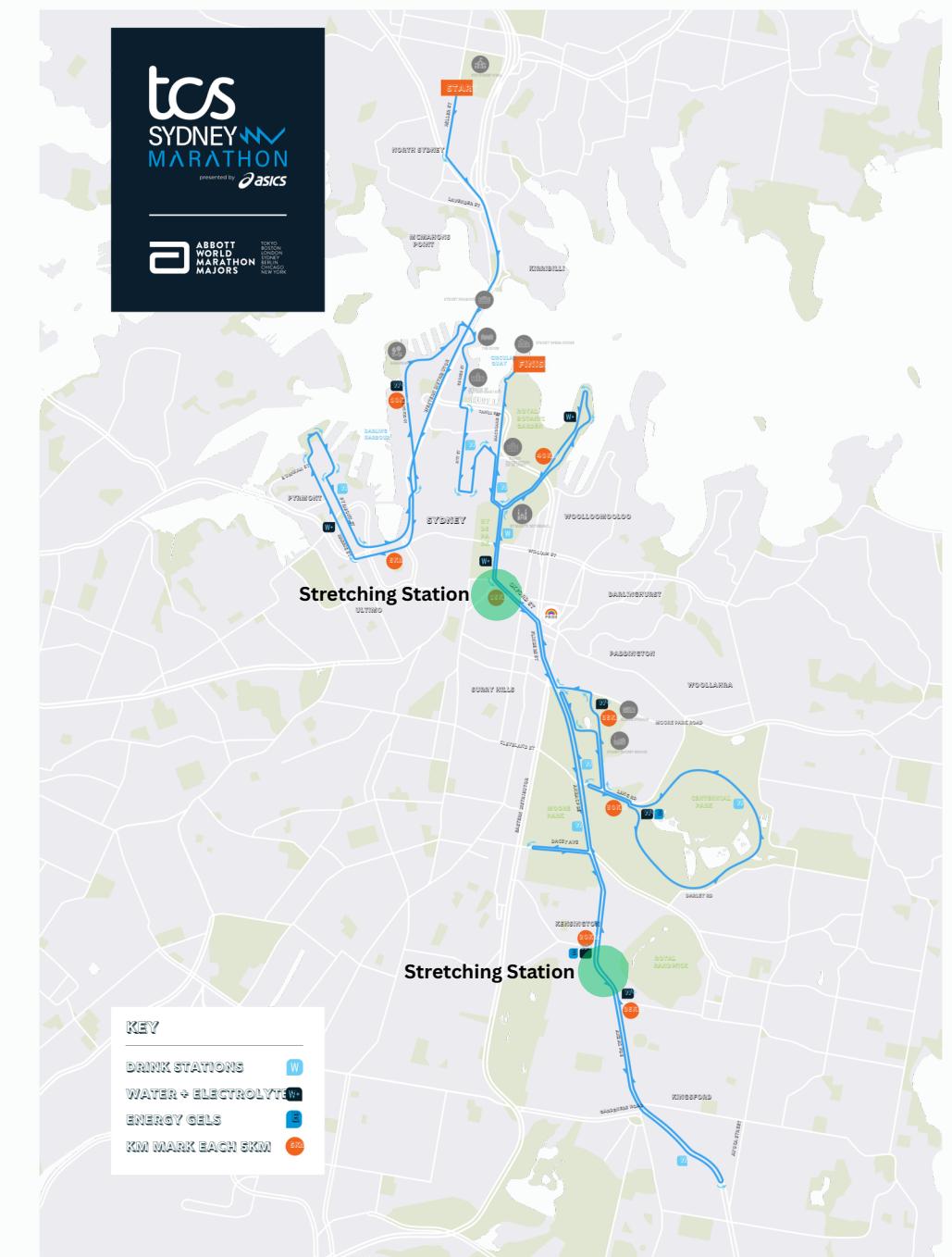
- There are currently no stretching stations in the middle, only start and end of the Sydney Marathon
- Stretching stations placed at 14-16 km and 22-24 km bins
- Beta coefficient = -0.116 (10.95% decrease)

stretching\_station -0.1157872 0.0227983 -5.079 3.80e-07 \*\*\*

bin	prop	expected_injuries_aftergel	Number of Medical Staff_aftergel	expected_injuries_afterstretch	Number of Medical Staff_afterstretch
1	0.0006	0.3000	2	0.30000	2
2	0.0039	2.4000	2	2.40000	2
3	0.0092	5.6000	2	5.60000	2
4	0.0160	9.8000	2	9.80000	2
5	0.0237	14.5000	3	14.50000	3
6	0.0321	14.4256	3	14.42560	3
7	0.0406	18.3264	4	18.32640	4
8	0.0492	22.1536	5	19.73221	4
9	0.0573	25.7600	6	22.94443	5
10	0.0647	29.1456	6	25.95999	6
11	0.0711	43.5000	9	43.50000	9
12	0.0762	46.6000	10	41.50662	9
13	0.0798	48.8000	10	43.46616	9
14	0.0815	49.9000	10	44.44593	9
15	0.0811	49.6000	10	49.60000	10
16	0.0782	47.8000	10	47.80000	10
17	0.0725	44.4000	9	44.40000	9
18	0.0637	39.0000	8	39.00000	8
19	0.0514	31.5000	7	31.50000	7
20	0.0351	21.5000	5	21.50000	5
21	0.0137	8.4000	2	8.40000	2

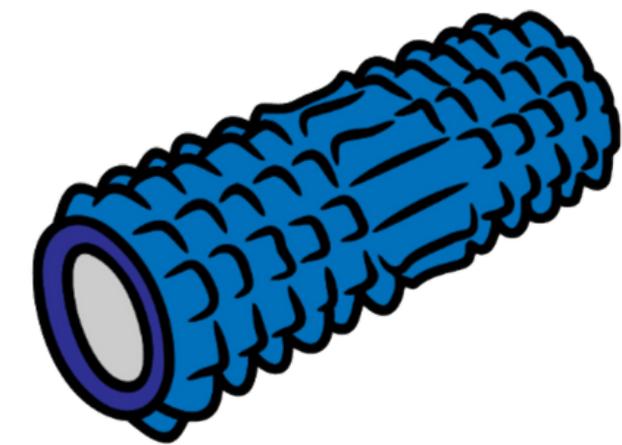
**Injuries Decrease: 572 - 530 = 42 (7.34%)**

**Medical Staff Decrease: 125 - 120 = 5 (4.00%)**



At stretching stations, individual use equipment should also be provided to accommodate a number of runners with different needs

- Foam rollers
- Resistance bands
- Slant boards



Equipment cleanliness and hygiene

- Volunteers should be placed to assist with cleaning/regular wipe-downs
- Alcohol-based disinfectant wipes or spray bottles should be provided



# HYDRATION STATION

hydration\_stations -0.0549068 0.0046262 -11.869 < 2e-16 \*\*\*

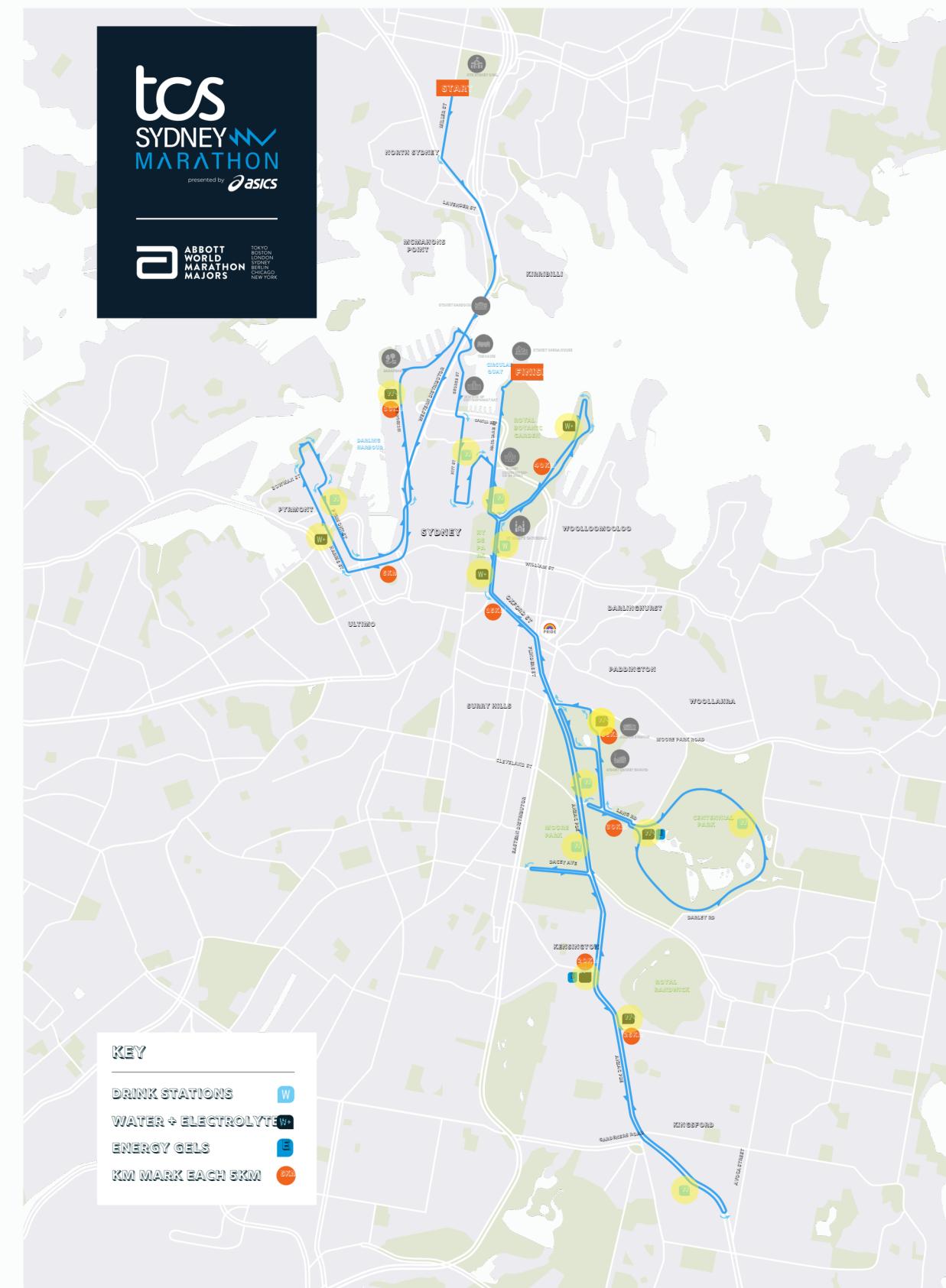
bin	prop	expected_injuries_afterstretch	Number of Medical Staff_afterstretch	expected_injuries_afterhydration	Number of Medical Staff_afterhydration
1	0-2 km	0.0006	0.30000	0.28398	2
2	2-4 km	0.0039	2.40000	2.27184	2
3	4-6 km	0.0092	5.60000	5.30096	2
4	6-8 km	0.0160	9.80000	9.27668	2
5	8-10 km	0.0237	14.50000	13.72570	3
6	10-12 km	0.0321	14.42560	13.65527	3
7	12-14 km	0.0406	18.32640	17.34777	4
8	14-16 km	0.0492	19.73221	18.67851	4
9	16-18 km	0.0573	22.94443	21.71920	5
10	18-20 km	0.0647	25.95999	24.57372	5
11	20-22 km	0.0711	43.50000	41.17710	9
12	22-24 km	0.0762	41.50662	39.29017	8
13	24-26 km	0.0798	43.46616	41.14507	9
14	26-28 km	0.0815	44.44593	42.07252	9
15	28-30 km	0.0811	49.60000	46.95136	10
16	30-32 km	0.0782	47.80000	45.24748	10
17	32-34 km	0.0725	44.40000	42.02904	9
18	34-36 km	0.0637	39.00000	36.91740	8
19	36-38 km	0.0514	31.50000	29.81790	6
20	38-40 km	0.0351	21.50000	20.35190	5
21	40-42 km	0.0137	8.40000	7.95144	2

Currently there are hydration stations at least every **5 kilometres**, with some being closer

- Pair up with an Australian hydration vest/belt company (Camelbak) to sponsor
- Beta coefficient = -0.0549 (5.34% decrease)

**Injuries Decrease: 530 - 519 = 11 (2.08%)**

**Medical Staff Decrease: 120 - 117 = 3 (2.50%)**



# HYDRATION VESTS: PRACTICAL CONSIDERATIONS

- Hydration vests offering more control and consistency over fluid intake, which is critical for personalized hydration strategies and can mitigate risks like hyponatremia (due to over-drinking at fixed stations) or dehydration (due to infrequent or crowded stations). They are particularly effective for slower runners, in hot conditions, or on courses with sparse aid.

If vests are being provided, organisers need to manage:

- Pre-race distribution or pickup
- Tracking inventory
- Post-race collection or disposal if they are reusable

Considerations regarding fit and comfort:

- Vests can add weight, especially when full, thus, runners should be informed to train with them beforehand
- Vests must be adjustable and secure to avoid bouncing or chafing during running.
- Offer variety of sizes or allow runners to bring their own if providing standard models isn't feasible.

CAMELBAK



HydroBak Light

★★★★★ 39 reviews

\$99.99

# FINANCIAL PLANNING



- The following table demonstrates the extra costs incurred/saved utilising previous year's spending as a base reference
- Note: Due to the addition of an extra gel station, there may be an increase in volunteers required, if this number is unable to be reached, labour may need to be hired which would result in increased hiring expenses

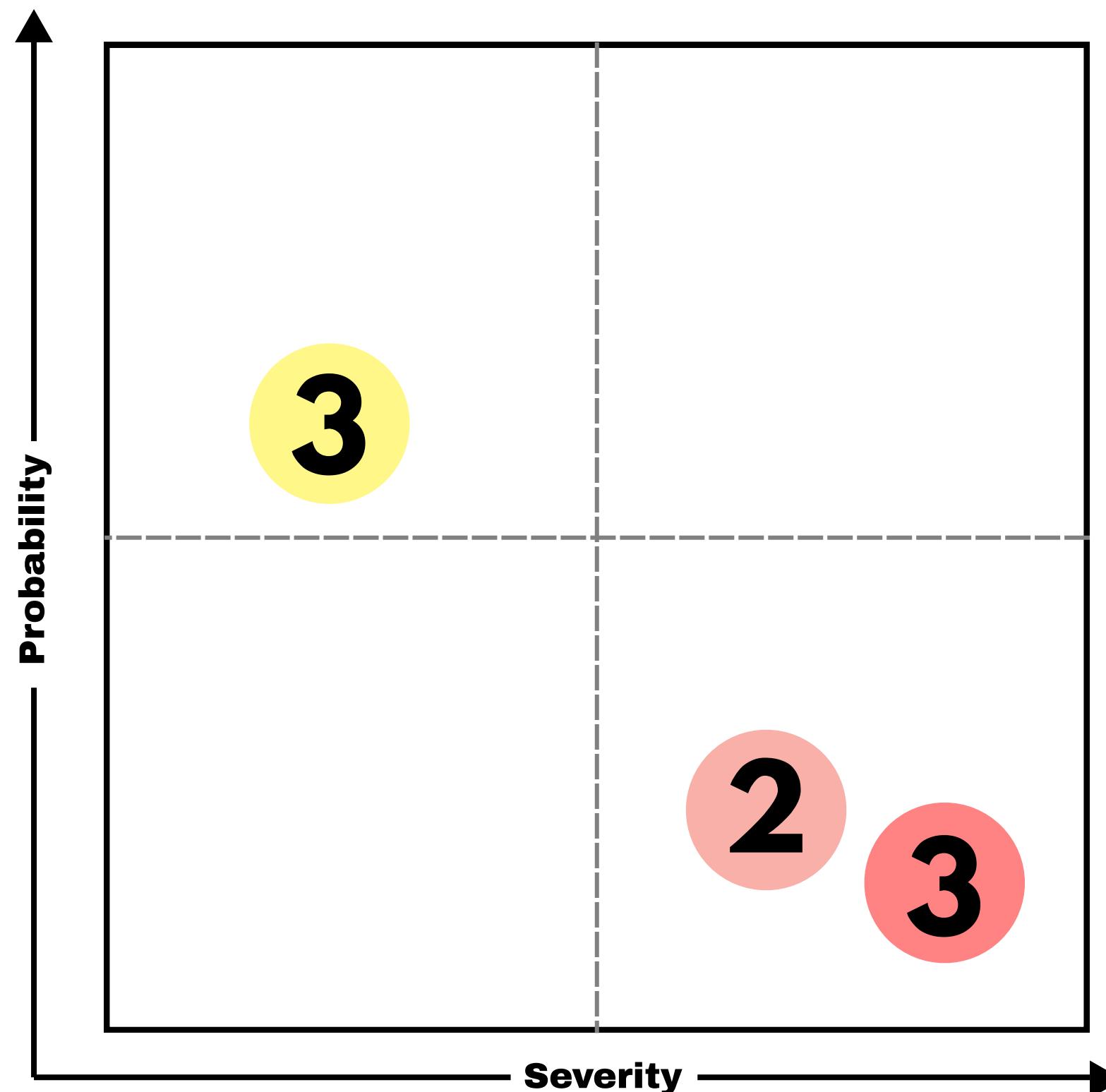
Service	Costs incurred	Cost Saved	Comments
Medical Staff Relieved (15 staff)		\$4,440	Based on salary of \$37/hour (Sourced from Glassdoor)
Foam Rollers (40 total)	\$360		Kmart (\$9 per roller)
Slant Board (40 total)	\$360		LOPE (\$9 per board)
Resistance Bands (40 total)	\$160		Kmart (\$4 per band)
Change in Gel Brand		\$X	
Extra Gel Support Station	\$X		Cancel out due to gel being 1/3 cheaper but extra gel station added
Total		\$3560	

# 04

## Risks and Mitigations



# RISKS



- 1 Failure to get partnership for hydration vests
- 2 Gel Allergen Risks
- 3 Cross contamination in stretching station

# MITIGATION



TRIHARD GANG

Key Factor	Risk	Mitigation	Proof of Concept
Gel Station	Exposure to allergens - Runners might accidentally take gels containing allergens (e.g. caffeine, soy, dairy)	Clear labelling and signage should be placed to inform runners Train volunteers to understand what allergens the gel contains Send an email to runners prior to the race informing them of the allergens in the gels provided - request that affected runners bring their own	
Stretching Station	Cross contamination at stretching station	Equipment requires regular wipe-downs, and cleaning supplies should be made available for volunteers	
Hydration Station	Failure to secure partnership for hydration vests	Attempt to implement a diversified approach to support hydration of runners, such as securing a partnership for running belts as an alternative	

# 05

## Assumptions and Limitations

# ASSUMPTIONS

As there is a logistic regression that predicts an individual's injuries, we must meet assumptions implicit to the model.

- There are no distinct polynomial or more complicated relationships between predictors and response variables, i.e. the relationship between the logit and the predictors are strictly linear.
- There are no separate variables which can be added to the logistic model other than what was provided.
- All observations of data are independent from one another, i.e. the injury of one person does not impact the injury of another
- All significant outliers which do not make sense have been removed.
- All measurements made are correct.

To allow for ease of interpretation and a base of reference to apply our recommendations onto, assumptions were made.

- Instead of converting injury probabilities to odds, applying a multiplicative factor, and converting back to probabilities before estimating expected injuries, we applied the reduction directly to the expected number of injuries. This is justified because the original probabilities are small, so the difference between directly reducing the probability and adjusting via odds is negligible, providing a reasonable approximation
- Assumed the current placements of gel supports, stretching supports, and hydration stations are identical to that of the Sydney Marathon stated information (Recommendations were applied onto this model)
- We assumed that due to the limiting advantages of stretching during a marathon, that its beneficial effects would only apply to runners for the next 6 kms (Chaabene et al., 2019), thus the multiplicative factor was only applied to the bins 14-16 km, 16-18 km, 18-20 km and 22-24 km, 24-26km, 26-28 km.

# LIMITATIONS

- Model is sensitive to outliers and high leverage points
- Model is not highly interpretable due to the nature of logistic regression
- The model does not model severity of injury or when injuries may occur, for which a theoretical distribution was required to be fit
- Injury reduction estimates are based on prior findings and may not reflect in this year's events
- Effectiveness of solutions will vary between runner, i.e. Effects of gel on each individual is dependent on factors such as height and weight.
- Recommendations require extra volunteers, space, equipment and setup time

# Bibliography and Appendix

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# SPORTS EQUIPMENT: KMAR AND LOPE



Foam Roller - Assorted

\$9 ea

★★★★★ 4.5 (105)

SKU : P\_42556435

Add to bag

afterpay zip Pay in 4

On orders up to \$2000 On orders up to \$1000 On orders up to \$2000

Learn more Learn more Learn more

How to get it

Shop at [Parramatta](#) Closes 10:00PM

Click & Collect • In stock Order before 12pm collect by 4pm today

In-store • In stock



LOPE Pilates Equipment

## LOPE Slant Boards

\$18.00

In stock, ready to ship

< 1 >

Add to cart - \$18.00



### 3 Pack Flat Resistance Band Set

\$12

★★★★★ 4.6 (9)

SKU : P\_43237333

Add to bag

afterpay zip Pay in 4

On orders up to \$2000 On orders up to \$1000 On orders up to \$2000

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Shop at [Parramatta](#) Closes 10:00PM

# PAY OF MEDIC STAFF: GLASSDOOR

## Event Medic Services Paramedic Hourly Pay

Australia ▾

All years of experience ▾

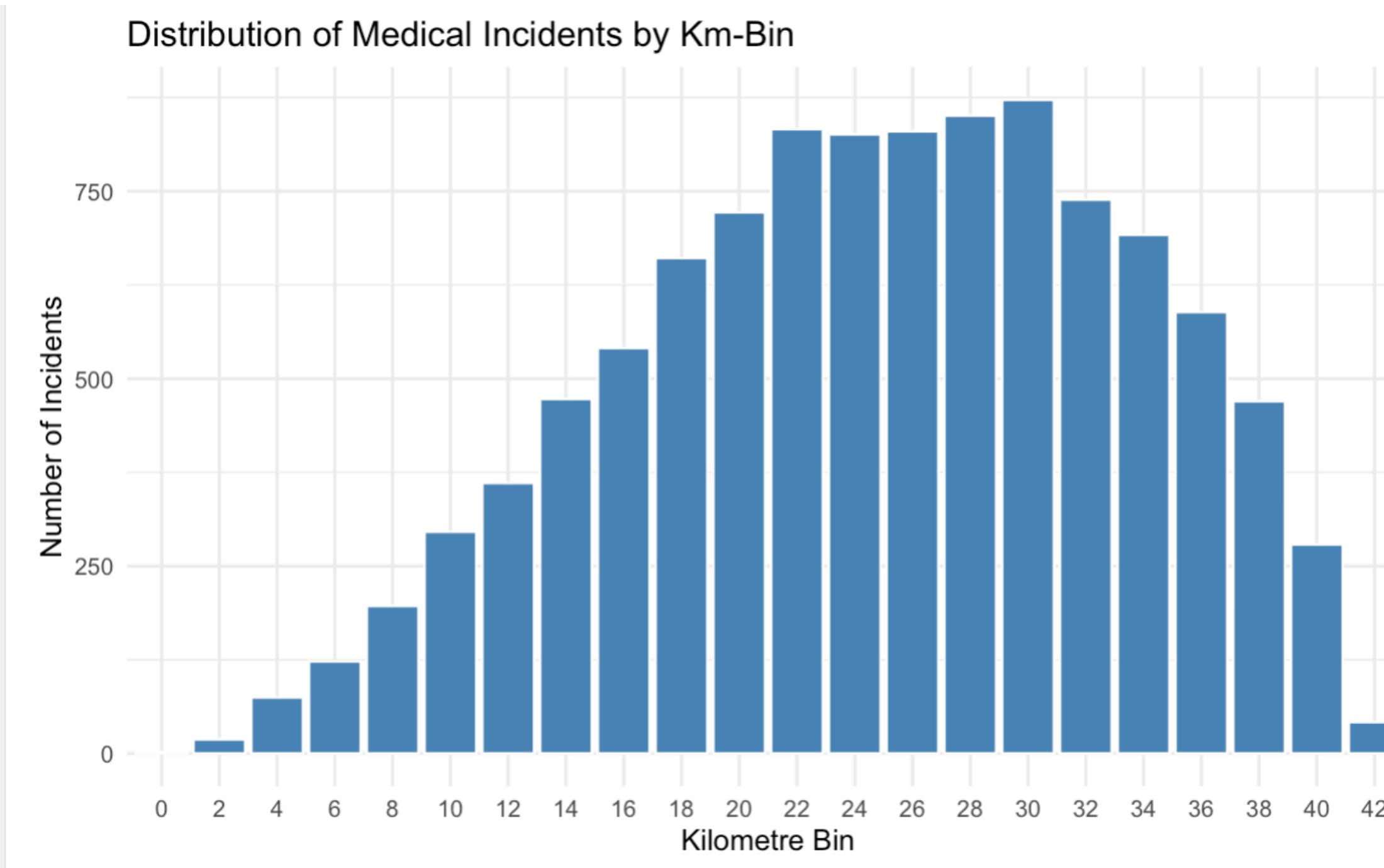
Base pay

**\$37-\$39**/hr

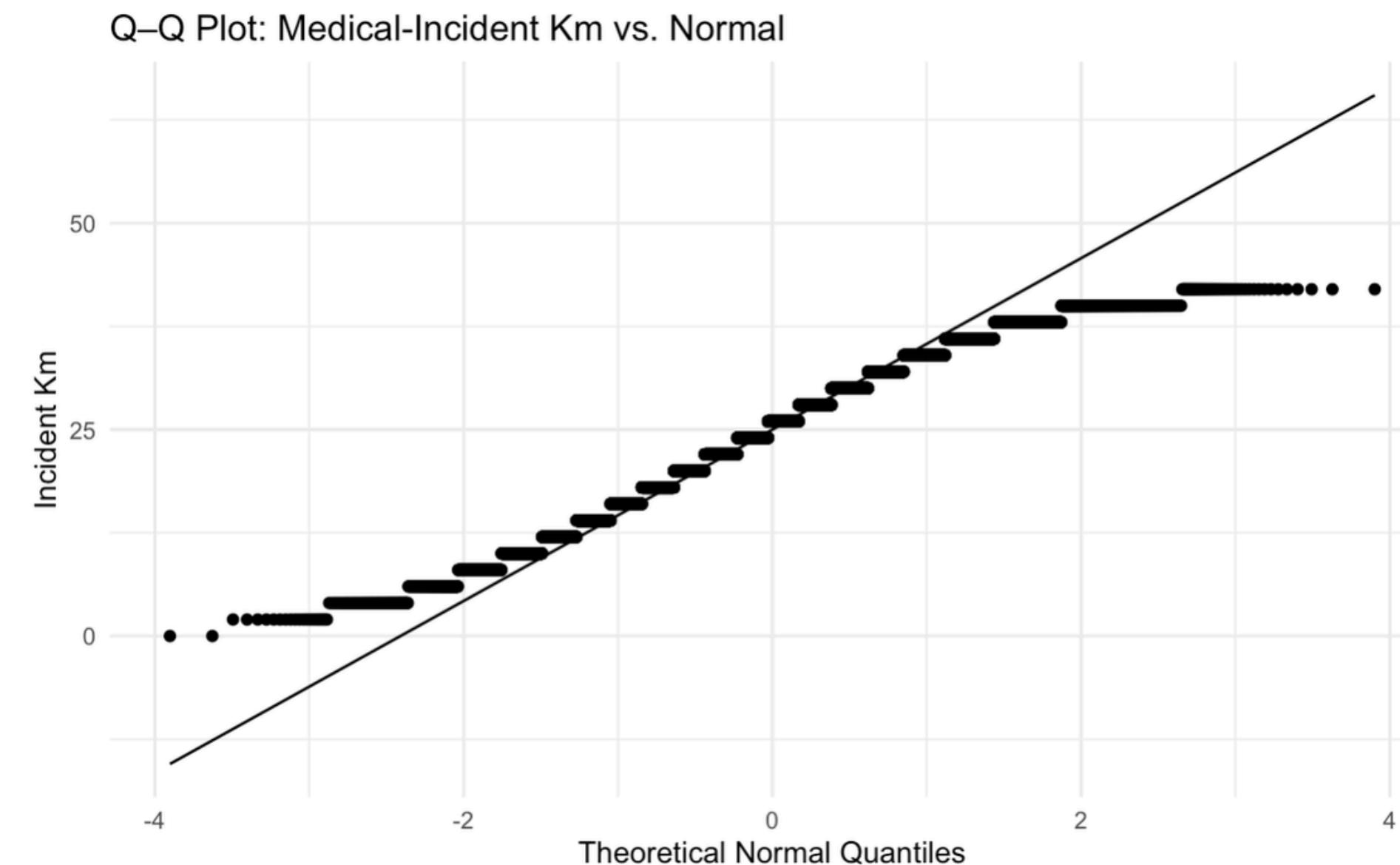
**\$38**/hr average

Cash Bonus, Stock Bonus, Profit Sharing, Commission Sharing, Tips have not  
been reported for this role

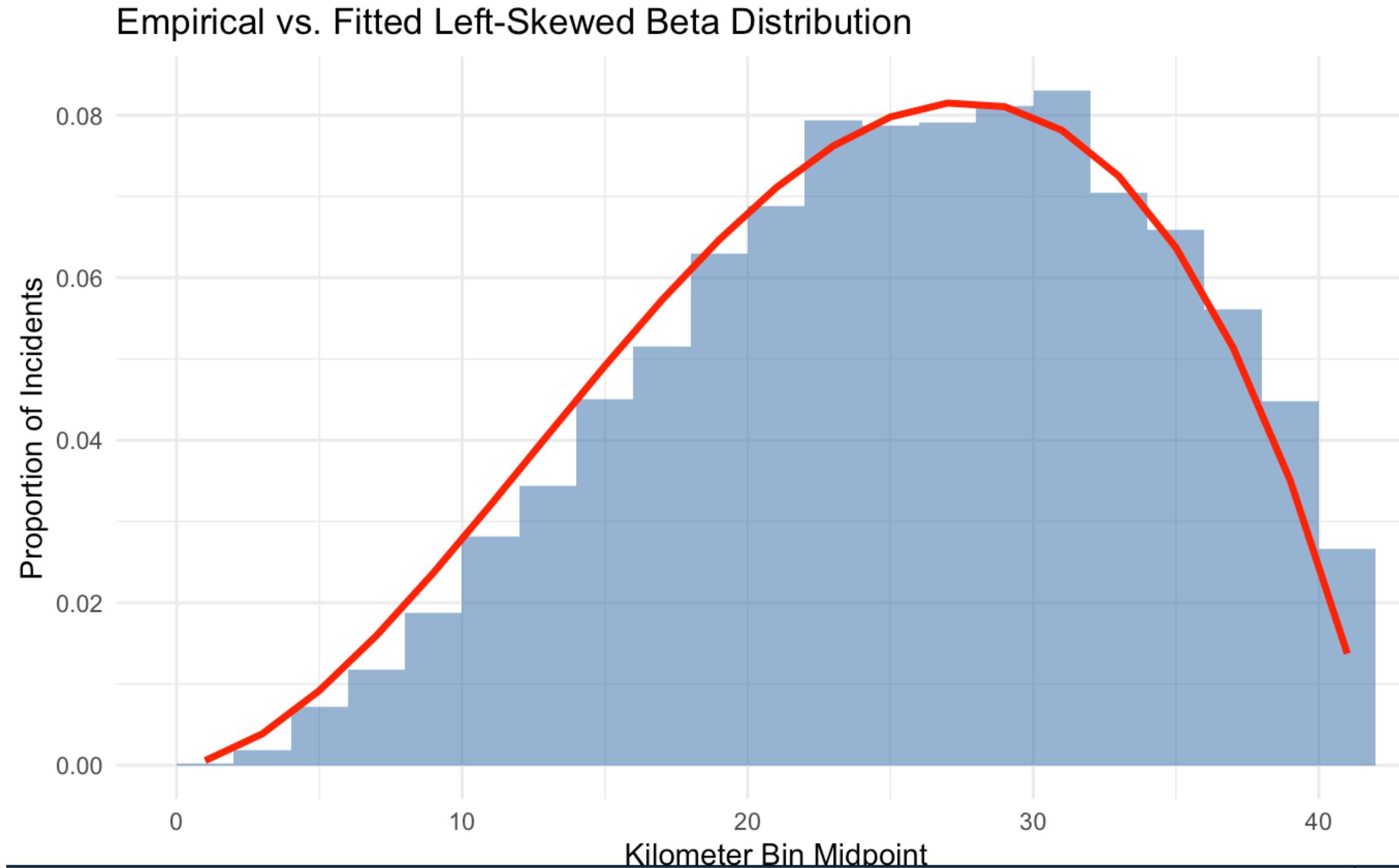
# DISTRIBUTION OF MEDICAL INCIDENTS PER 2KM



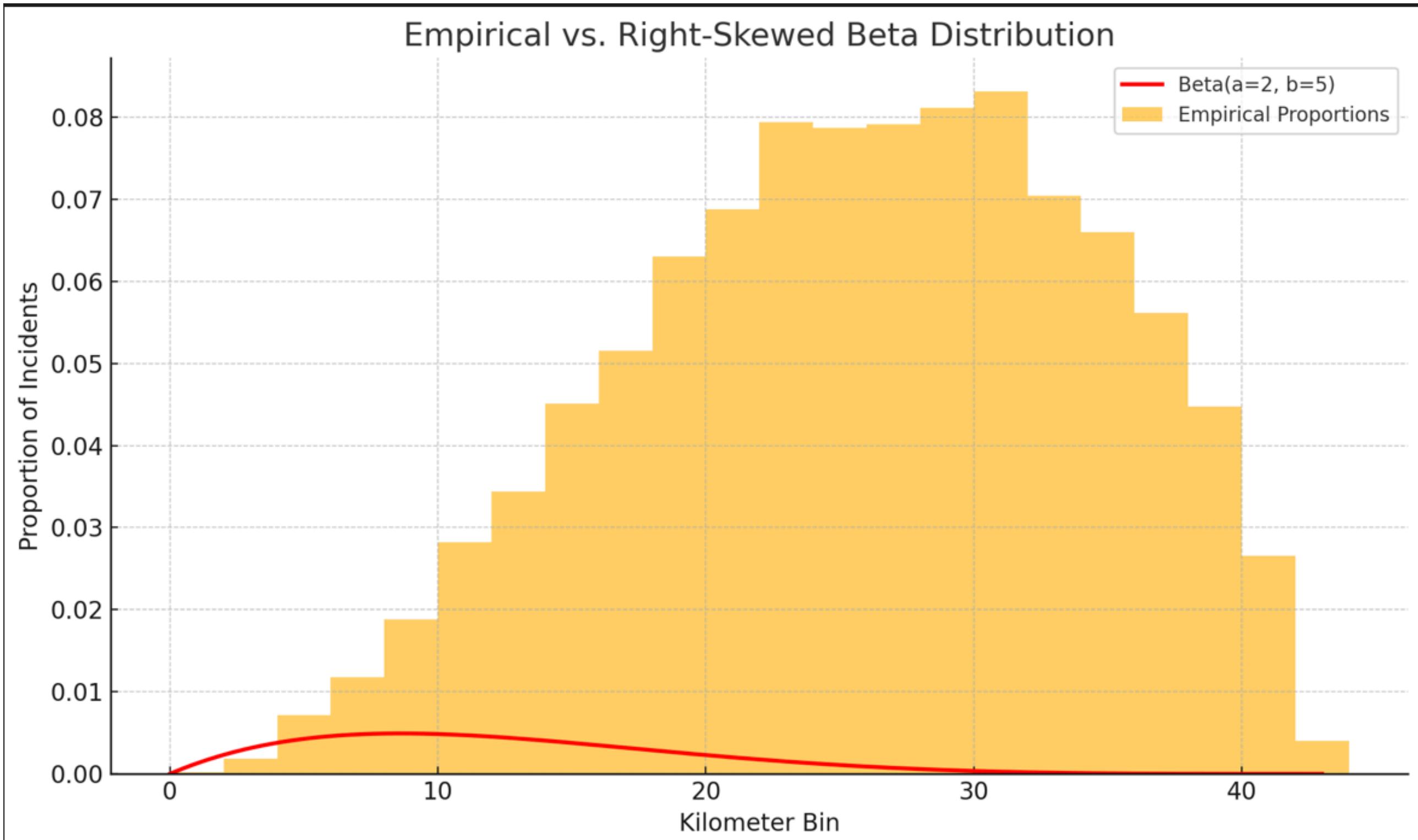
# Q-Q PLOT OF MEDICAL INCIDENTS EVERY 2KM VS NORMAL DISTRIBUTION



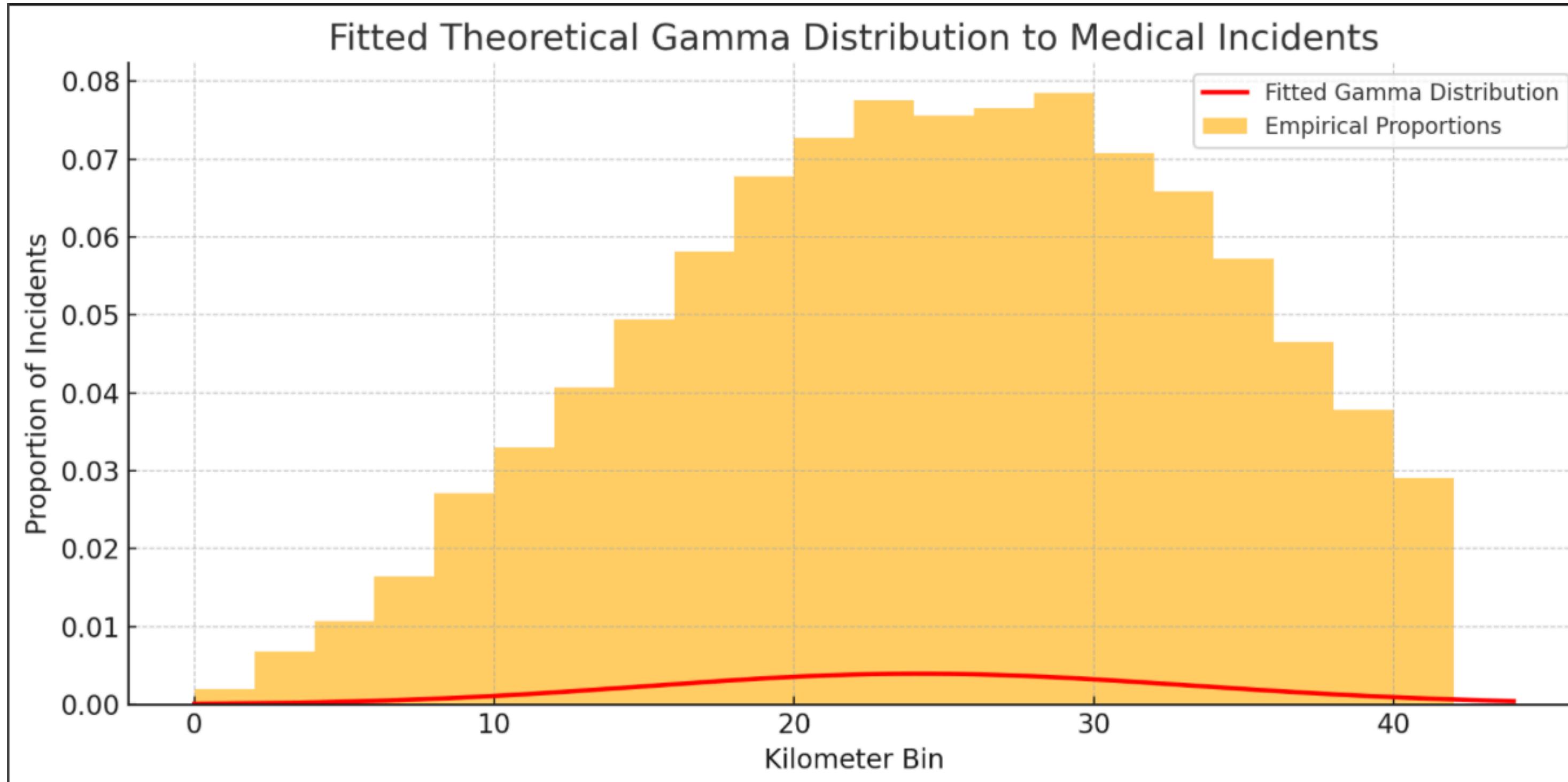
# DATA VS LEFT SKEWED BETA DISTRIBUTION



# DATA VS RIGHT SKEWED BETA DISTRIBUTION



# DATA VS GAMMA BETA DISTRIBUTION



# PAIRWISE PLOT OF INJURIES AND MARATHON FEATURES

Pairwise Scatterplot Matrix of Injuries and Marathon Features

