

# Is Covid-19 to Blame? Explaining Decreased Attendance in the 2021-22 NBA and NHL Seasons

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# Overview

- Today I am presenting my senior thesis I completed in April of this year.
- The thesis seeks to analyze whether Covid-19 activity impacted attendance to professional sports matches, specifically for the 2021-22 NBA and NHL Seasons.
- Here, "Covid-19 activity" is measured in two ways:
  - ① The lag weekly new Covid-19 cases/deaths (\*CBSA level).
  - ② The type of Covid-19 policy in place (home team level).
- These two Covid-19 variables, along with several control variables, are implemented in an OLS regression model to assess the impact Covid-19 activity had match attendance.
- This presentation will proceed by outlining the empirical and theoretical groundwork leading up to the model, present the full model and its results, and finish by discussing the results and their implications.

Feel free to ask any questions along the way!

# Attendance Stats/Graphs

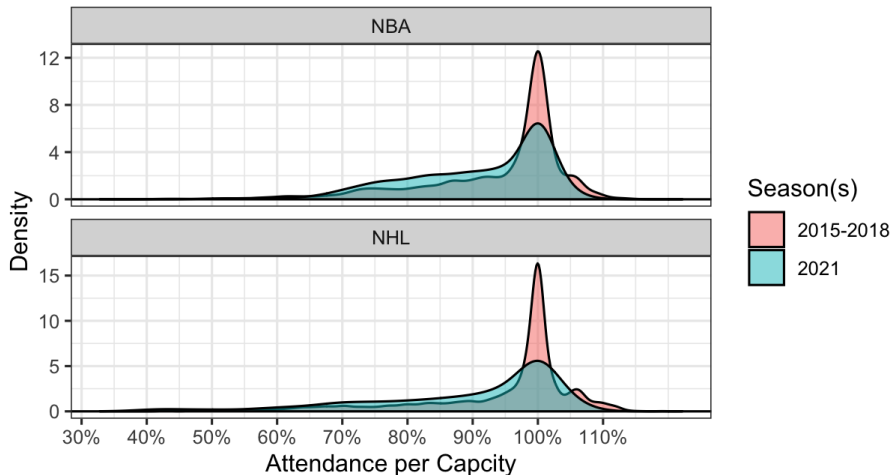
## Season-level Attendance Statistics

|     | Season  | Attendance per Capacity |        |       |       |          |            | Attendance per Capacity<br>Home-level Variance |       |       |          |
|-----|---------|-------------------------|--------|-------|-------|----------|------------|--|-------|-------|----------|
|     |         | Mean                    | Median | Min   | Max   | $\sigma$ | $\sigma^2$ | Mean   | Min   | Max   | $\sigma$ |
| NBA | 2015-16 | 0.940                   | 0.998  | 0.463 | 1.150 | 0.124    | 0.015      | 0.005  | 0.000 | 0.022 | 0.006    |
|     | 2016-17 | 0.940                   | 0.998  | 0.328 | 1.132 | 0.117    | 0.014      | 0.005  | 0.000 | 0.022 | 0.007    |
|     | 2017-18 | 0.947                   | 0.991  | 0.496 | 1.101 | 0.091    | 0.008      | 0.005  | 0.000 | 0.013 | 0.005    |
|     | 2018-19 | 0.943                   | 0.991  | 0.521 | 1.105 | 0.095    | 0.009      | 0.004  | 0.000 | 0.021 | 0.005    |
|     | 2021-22 | 0.910                   | 0.945  | 0.428 | 1.098 | 0.110    | 0.012      | 0.006  | 0.000 | 0.027 | 0.006    |
| NHL | 2015-16 | 0.951                   | 1.000  | 0.483 | 1.222 | 0.118    | 0.014      | 0.005  | 0.000 | 0.031 | 0.007    |
|     | 2016-17 | 0.946                   | 1.000  | 0.433 | 1.123 | 0.126    | 0.016      | 0.004  | 0.000 | 0.023 | 0.007    |
|     | 2017-18 | 0.952                   | 1.000  | 0.422 | 1.127 | 0.118    | 0.014      | 0.004  | 0.000 | 0.024 | 0.007    |
|     | 2018-19 | 0.956                   | 0.993  | 0.533 | 1.145 | 0.104    | 0.011      | 0.004  | 0.000 | 0.027 | 0.007    |
|     | 2021-22 | 0.894                   | 0.954  | 0.368 | 1.073 | 0.148    | 0.022      | 0.006  | 0.000 | 0.016 | 0.005    |

2021-22 attendance is down, for both the NBA and NHL. Greater variance too.

# Attendance Stats/Graphs

Distribution of Attendance per Capacity  
2015-2018 Seasons VS. 2021 Season



# Motivation

Why might we be interested in studying this decrease in attendance in the 2021-22 season?

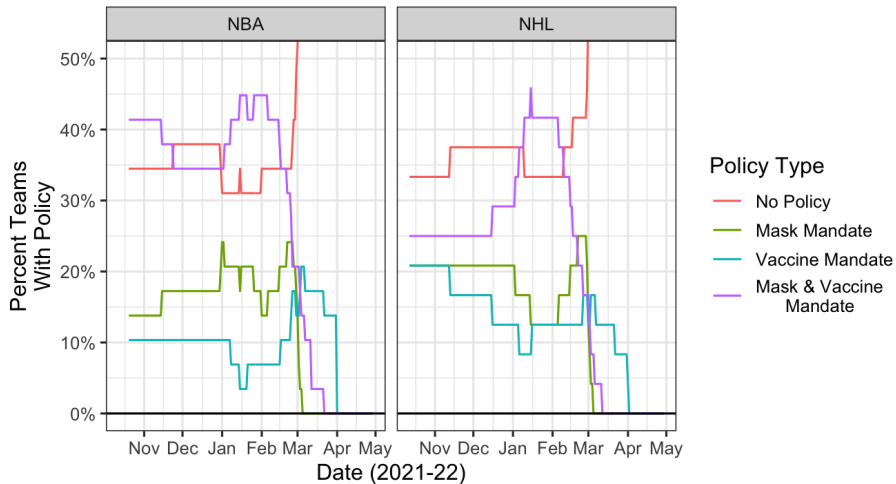
- ➊ Natural step forward in the literature:
  - Reade et al. (2020) → Belarussian Premier League
  - Reade and Singleton (2021) → European Football
  - Humphreys et al. (2021) → WTP for Covid-19 preventative measures.
- ➋ New Covid-19 policies to analyze (masks, vaccines, etc.).
- ➌ No stadium capacity restrictions (in the U.S.).
- ➍ Fans may have new perspectives on Covid-19 (Omicron).

Why not the 2020-21 season?

- ➊ Heavy capacity restrictions.
- ➋ Reduced season length. NBA: 82 → 72, NHL: 82 → 56
- ➌ Worse data documentation.

# Covid-19 Policies

## Covid-19 Policy Types in the NBA and NHL Over the 2021-22 Season



# Data Outline

## Basic Data Structure

| Date       | Home     | Match Stats | CBSA        | Covid Data |
|------------|----------|-------------|-------------|------------|
| 2022-02-14 | Wild     | ...         | Minneapolis | ...        |
| 2022-02-14 | Sharks   | ...         | San Jose    | ...        |
| 2022-02-15 | Devils   | ...         | NYC         | ...        |
| 2022-02-15 | Penguins | ...         | Pittsburgh  | ...        |

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Unique Obsv. Vars

- Date (day) and the home team uniquely identify observations.



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Unique Obsv. Vars

Day-Home Level

- Date (day) and the home team uniquely identify observations.
- Match Stats are variables at the day-home level, such as the away team, bettings odds, or attendance. Source → ESPN (mostly).

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Unique Obsv. Vars

Day-Home Level

Week-CBSA Level

- Date (day) and the home team uniquely identify observations.
- Match Stats are variables at the day-home level, such as the away team, bettings odds, or attendance. Source → ESPN (mostly).
- The Covid-19 data is at the weekly-CBSA level and contains data on new cases and deaths. Source → The New York Times.

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- Match Stats are variables at the day-home level, such as the away team, bettings odds, or attendance. Source → ESPN (mostly).
- The Covid-19 data is at the weekly-CBSA level and contains data on new cases and deaths. Source → The New York Times.
- 5 total seasons of data. 4 controls (2015-2018), 1 with Covid-19 (2021-22).

# Covid-19 Stats/Graphs

## League-level Covid-19 Statistics

|     | Type    | Lag Weekly New Cases (per thousand) |        |       |        |          | Lag Weekly New Deaths |        |       |      |          |
|-----|---------|-------------------------------------|--------|-------|--------|----------|-----------------------|--------|-------|------|----------|
|     |         | Mean                                | Median | Min   | Max    | $\sigma$ | Mean                  | Median | Min   | Max  | $\sigma$ |
| NBA | Normal  | 26.13                               | 7.67   | -1.34 | 586.49 | 62.50    | 133                   | 86     | -2295 | 1803 | 204      |
|     | Imputed | 26.29                               | 7.95   | 0.24  | 586.49 | 62.51    | 137                   | 86     | 0     | 1803 | 178      |
| NHL | Normal  | 26.85                               | 8.54   | 0.00  | 586.49 | 63.23    | 151                   | 97     | -2295 | 1803 | 265      |
|     | Imputed | 27.07                               | 8.69   | 0.46  | 586.49 | 63.23    | 156                   | 98     | 0     | 1803 | 241      |

## Notes:

- Using 1 week lag to better encapsulate fan reactions.
- Negative values lead us to impute the data.

| Week   | Cases | Impute<br>→ | Week   | Cases |
|--------|-------|-------------|--------|-------|
| Week 1 | 1000  |             | Week 1 | 1000  |
| Week 2 | -512  |             | Week 2 | 1500  |
| Week 3 | 2000  |             | Week 3 | 2000  |

# Covid-19 Stats/Graphs

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## Observations:

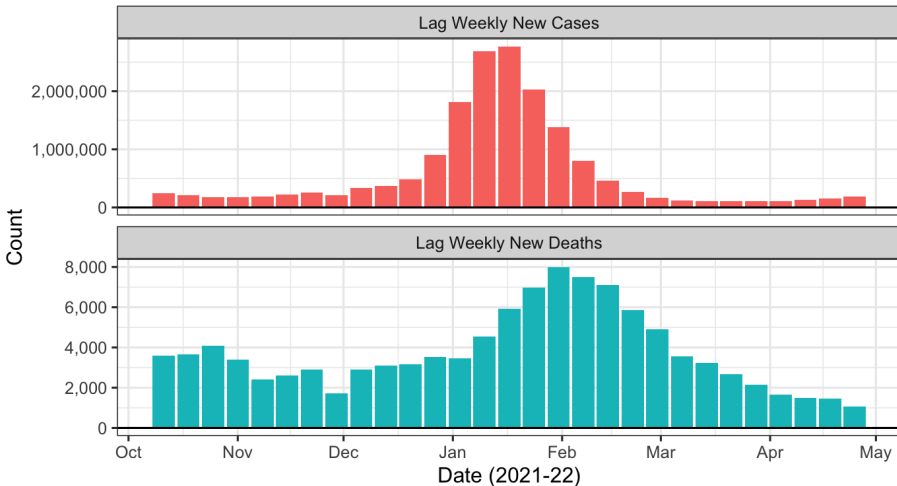
- Case and death data are heavily right-skewed.
- Extreme standard deviations:
  - Omicron spike.
  - Differences in CBSA populations.

Need to control for differences in CBSA populations → Convert to quartiles.

# Covid-19 Stats/Graphs

## Lag Weekly New Covid-19 Cases/Deaths

10/11/2021 to 4/25/2022, Aggregated Over Select CBSAs



# Model

The primary regression is defined as the following:

$$\begin{aligned}\text{Attendance per Capacity}_{ijg} = & \beta_0 + \beta_1 \text{Quartile}(\text{Lag}(\text{Cases/Deaths}_{ig})) + \Phi \text{Policy}_{ih} \\ & + \Gamma X_{ijg} + \beta_2 \text{Home Rank}_{is} + \beta_3 \text{Away Rank}_{js} \\ & + \delta_i + \delta_j + \epsilon_{ijg}\end{aligned}$$

Where  $i$  = Home level,  $j$  = Away level,  $g$  = game level, and:

$$\begin{aligned}\Phi \text{Policy}_{ih} & \in \{\text{Masks}_{ig}, \text{Vaccines}_{ig}, \text{Masks}_{ig} \times \text{Vaccines}_{ig}\} \\ \Gamma X_{ijg} & \in \{\text{Odds}_{ijg}, \delta_g^{\text{day}}, \delta_g^{\text{month}}, \delta_g^{\text{season}}, \delta_g^{\text{month}} \times \delta_g^{2021-22}\}\end{aligned}$$

**Variable(s):**

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**Variable(s):** Lag Weekly New Cases/Deaths Quartile



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**Variable(s):** Policy Indicators

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**Variable(s):** Betting Odds, day of week fixed effects, month fixed effects, season fixed effects, month-2021-22 season interaction.

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**Variable(s):** Home team rank, away team rank.

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**Variable(s):**      Home team fixed effects, away team fixed effects.

# Key Results

## Regression Results. Standard Errors Clustered at Home Team Level

| Variable                  | Attendance per Capacity |                |                             |                 |
|---------------------------|-------------------------|----------------|-----------------------------|-----------------|
|                           | NBA                     |                | NHL                         |                 |
|                           | Cases                   | Deaths         | Cases                       | Deaths          |
| 2021-22 Season            | -5.02** (2.36)          | -5.59** (2.52) | -5.67** (2.82)              | -6.92** (3.18)  |
| Quartile 2                | -1.40 (0.92)            | -0.43 (0.94)   | -0.46 (1.15)                | 1.07 (1.52)     |
| Quartile 3                | -0.11 (0.99)            | -0.33 (0.66)   | -0.49 (1.37)                | 1.14 (1.56)     |
| Quartile 4                | -0.20 (0.97)            | -0.37 (1.14)   | 0.38 (1.68)                 | 3.10 (2.25)     |
| Masks                     | 2.84 (2.16)             | 2.73 (2.13)    | 8.19* (4.30)                | 8.17* (4.25)    |
| Vaccines                  | 2.48 (2.89)             | 2.42 (2.94)    | -14.28** (6.24)             | -14.76** (6.37) |
| Masks × Vaccines          | -5.00 (3.48)            | -4.84 (3.52)   | 7.26 (6.24)                 | 7.40 (8.03)     |
| 2021-22 Season × November | 1.06 (3.48)             | 1.36 (1.10)    | 1.95 (1.73)                 | 2.28 (1.72)     |
| 2021-22 Season × December | 1.66 (1.19)             | 1.99* (1.16)   | 0.29 (2.19)                 | 0.36 (1.89)     |
| 2021-22 Season × January  | 0.18 (1.60)             | 0.88 (1.56)    | -0.91 (2.38)                | -1.19 (1.71)    |
| 2021-22 Season × February | 2.66* (1.38)            | 3.24** (1.56)  | -0.21 (2.27)                | -1.27 (1.90)    |
| 2021-22 Season × March    | 4.01*** (1.42)          | 4.60*** (1.51) | 3.86 (2.89)                 | 4.30 (2.90)     |
| 2021-22 Season × April    | 5.80** (2.27)           | 6.16*** (2.22) | -1.58 (2.51)                | -0.64 (3.09)    |
| Observations              | 5,951                   | 5,951          | 4,726                       | 4,726           |
| Adjusted R <sup>2</sup>   | 0.54                    | 0.54           | 0.63                        | 0.63            |
| <i>Note:</i>              |                         |                | *p<0.1; **p<0.05; ***p<0.01 |                 |

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The 2021-22 variable is negative and significant, as expected.

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| 2021-22 Season × April    | 5.80** (2.27)           | 6.16*** (2.22) | -1.58 (2.51)                | -0.64 (3.09)    |
| Observations              | 5,951                   | 5,951          | 4,726                       | 4,726           |
| Adjusted R <sup>2</sup>   | 0.54                    | 0.54           | 0.63                        | 0.63            |
| Note:                     |                         |                | *p<0.1; **p<0.05; ***p<0.01 |                 |

Quartile variables are insignificant, and are unexpectedly positive in some cases.

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| Masks                     | 2.84 (2.16)             | 2.73 (2.13)    | 8.19* (4.30)                | 8.17* (4.25)    |
| Vaccines                  | 2.48 (2.89)             | 2.42 (2.94)    | -14.28** (6.24)             | -14.76** (6.37) |
| Masks × Vaccines          | -5.00 (3.48)            | -4.84 (3.52)   | 7.26 (6.24)                 | 7.40 (8.03)     |
| 2021-22 Season × November | 1.06 (3.48)             | 1.36 (1.10)    | 1.95 (1.73)                 | 2.28 (1.72)     |
| 2021-22 Season × December | 1.66 (1.19)             | 1.99* (1.16)   | 0.29 (2.19)                 | 0.36 (1.89)     |
| 2021-22 Season × January  | 0.18 (1.60)             | 0.88 (1.56)    | -0.91 (2.38)                | -1.19 (1.71)    |
| 2021-22 Season × February | 2.66* (1.38)            | 3.24** (1.56)  | -0.21 (2.27)                | -1.27 (1.90)    |
| 2021-22 Season × March    | 4.01*** (1.42)          | 4.60*** (1.51) | 3.86 (2.89)                 | 4.30 (2.90)     |
| 2021-22 Season × April    | 5.80** (2.27)           | 6.16*** (2.22) | -1.58 (2.51)                | -0.64 (3.09)    |
| Observations              | 5,951                   | 5,951          | 4,726                       | 4,726           |
| Adjusted R <sup>2</sup>   | 0.54                    | 0.54           | 0.63                        | 0.63            |
| Note:                     |                         |                | *p<0.1; **p<0.05; ***p<0.01 |                 |

**NBA Policy** → Individual policy variables are positive, but their interaction is negative, and all are insignificant.



# Key Results

## Regression Results. Standard Errors Clustered at Home Team Level

| Variable                  | Attendance per Capacity |                |                             |                 |
|---------------------------|-------------------------|----------------|-----------------------------|-----------------|
|                           | NBA                     |                | NHL                         |                 |
|                           | Cases                   | Deaths         | Cases                       | Deaths          |
| 2021-22 Season            | -5.02** (2.36)          | -5.59** (2.52) | -5.67** (2.82)              | -6.92** (3.18)  |
| Quartile 2                | -1.40 (0.92)            | -0.43 (0.94)   | -0.46 (1.15)                | 1.07 (1.52)     |
| Quartile 3                | -0.11 (0.99)            | -0.33 (0.66)   | -0.49 (1.37)                | 1.14 (1.56)     |
| Quartile 4                | -0.20 (0.97)            | -0.37 (1.14)   | 0.38 (1.68)                 | 3.10 (2.25)     |
| Masks                     | 2.84 (2.16)             | 2.73 (2.13)    | 8.19* (4.30)                | 8.17* (4.25)    |
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| Masks × Vaccines          | -5.00 (3.48)            | -4.84 (3.52)   | 7.26 (6.24)                 | 7.40 (8.03)     |
| 2021-22 Season × November | 1.06 (3.48)             | 1.36 (1.10)    | 1.95 (1.73)                 | 2.28 (1.72)     |
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| Observations              | 5,951                   | 5,951          | 4,726                       | 4,726           |
| Adjusted R <sup>2</sup>   | 0.54                    | 0.54           | 0.63                        | 0.63            |
| Note:                     |                         |                | *p<0.1; **p<0.05; ***p<0.01 |                 |

**NHL Policy** → Mask and mask-vaccine interaction is positive, while vaccines are markedly negatively and significant.

# Key Results

## Regression Results. Standard Errors Clustered at Home Team Level

| Variable                  | Attendance per Capacity |                |                             |                 |
|---------------------------|-------------------------|----------------|-----------------------------|-----------------|
|                           | NBA                     |                | NHL                         |                 |
|                           | Cases                   | Deaths         | Cases                       | Deaths          |
| 2021-22 Season            | -5.02** (2.36)          | -5.59** (2.52) | -5.67** (2.82)              | -6.92** (3.18)  |
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| Observations              | 5,951                   | 5,951          | 4,726                       | 4,726           |
| Adjusted R <sup>2</sup>   | 0.54                    | 0.54           | 0.63                        | 0.63            |
| Note:                     |                         |                | *p<0.1; **p<0.05; ***p<0.01 |                 |

Large and positive coefficients on the 2021-22 season and March/April variables suggest evidence of a comeback effect in the NBA. Not observed in the NHL.

## Takeaways from results:

- Weekly new cases/deaths did not appear to impact attendance. Robust to different lags and different CBSA-county definitions.
- Policy appeared to only impact attendance in the NHL. Masks appeared to bring in attendance and vaccines drove it away.
- In the NBA, attendance increased towards the end of the season, suggesting fan's may have perceived Covid-19 as less of a threat as time passed. This did not occur in the NHL.

## Conclusion:

While attendance overall decreased in both the NBA and NHL during the 2021-22 season, only weak evidence suggests direct Covid-19 activity impacted this decrease. This somewhat agrees with the relevant literature, which too finds weak/inconsistent results.

# Going Forward

A few things to consider going forward:

- Adjust case/death data by CBSA population.
- Find an instrument for cases/deaths → Bordering counties?
- Add more controls (time of the game, weather, power rankings).
- Track local news/media coverage? GDELT.

# Thank You!

## Questions?