Effectiveness of Mass Vaccination in Brazil against Severe COVID-19 cases

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WHO meeting - Oct 25, 2021
Introduction - Epidemiological scenario

- Death toll of COVID-19 in Brazil: > 600,000 confirmed deaths
- Hospitalized cases
Vaccination rollout

- Vaccination started Jan/2021
  - ChAdOx1 nCov19 (AstraZeneca) and CoronaVac (SinoVac)
  - Early May BNT162b2 (Pfizer) - Mid-June Ad26.COV2-S (Janssen)
- Full regimen - interval between doses
  - CoronaVac: 4 weeks
  - ChAdOx1 nCov19 and BNT162b2: 12 weeks

- Fiocruz has an agreement with AstraZeneca to produce ChAdOx1 nCov-19 vaccines
This work: Effectiveness of vaccination

- Severe cases/deaths with confirmation or likely, i.e., generally cases with symptoms taking to hospitalization
- Massive data analysis
- Analysis by age groups: CoronaVac, ChAdOx1 nCov19, BNT162b2*
- Data sources: public databases SIVEP-gripe (SRAG) e SI-PNI (vaccination) in probabilistic linkage
  - Last date of symptoms: 2021-07-19
  - Last date of vaccine: 2021-06-30
- > 66 million records and > 1 million hosp./deaths

*Short time to observe outcomes after 2nd dose of BNT162b2
Short time to observe outcomes after Ad26.C0V2-S
Outcomes in immunized individuals

1st dose

2nd dose

X

14 days

14 days

Evaluation time t

Person-time

X: severe event in immunized
Outcomes in non-immunized

Vaccination starts 14 days

X: severe event in non-immunized
Cohort (Dataset)

- Cases in vaccinated individuals after 14 days of vaccination
- Vaccinated individuals with no outcomes
  - Total person-time amount (vaccinated)

- Cases in non-immunized individuals: unvaccinated or symptoms onset before time given by first dose plus 14 days
- All vaccinated nationwide (vaccine coverage in person-time)
  - Based on population projections, we have estimates of non-vaccinated (age groups/states)
  - Total person-time amount (unvaccinated)
Cohort: flowchart

Number of records
N=68,382,784

Vaccinated records
N=65,804,427

Cases
N=1,073,509

Different vaccine information: 667,162
Missing first dose information: 6,692

Electronic Health Record Cohort
N=65,708,929

Cases not confirmed by laboratorial exams: 6,437

Electronic Health Record Cohort - exploratory analysis
N=65,706,029

Individuals less than 20 years old
495,260

National electronic health record cohort - Statistical analysis
N=65,210,769

Total cases: 1,018,662
Total vaccinated (at least first dose): 64,678,797

https://www.medrxiv.org/content/10.1101/2021.09.10.21263084v1
Methodology

- quasi-ecological, individual data with information that we can aggregate
- Number of cases by states and age groups
  - Person-time (immunized and non-immunized)

- Rationale: rate of cases per total person-time (immunized/non-immunized)
  VE: 1- RR
Statistical analysis

- Cases \( Y_i \) aggregated by region and age groups

Cases are described by a mixed-effects Poisson model:

\[ Y_i \sim \text{Poisson}(\lambda_i), \]

where \( \log(\lambda_i) = \log(D_i) + \gamma_{h(i)} + \beta_{a(i)} \gamma_i \), \( \gamma_{h(i)} \) and \( \beta_{a(i)} \) are random effects, in particular \( \beta_{a(i)} \) is an age-varying effect.

- Person-time \( D_i \). Bayesian framework, analyzed with JAGS.

- Effectiveness: \( VE = 1 - RR \), which can be estimated per age group, given the age-varying effect. Also, the same applies for deaths as outcome, regions, and status (first dose/second dose).
Most people (> 17 million) in full regimen with CoronaVac
> 36 million with first dose of ChAdOx1

<table>
<thead>
<tr>
<th></th>
<th>ChAdOx1 nCov-19</th>
<th>CoronaVac</th>
<th>BNT162b2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+ dose (%)</td>
<td>N = 36,558,236</td>
<td>N = 21,421,043</td>
<td>N = 6,812,761</td>
</tr>
<tr>
<td>full regimen (%)</td>
<td>N = 3,112,029</td>
<td>N = 17,321,933</td>
<td>N = 38,745</td>
</tr>
</tbody>
</table>

Vaccinated - total
## Vaccinated - age groups

<table>
<thead>
<tr>
<th>Age group</th>
<th>ChAdOx1 nCov-19</th>
<th>CoronaVac</th>
<th>BNT162b2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1+ dose (%)</td>
<td>full regimen (%)</td>
<td>1+ dose (%)</td>
</tr>
<tr>
<td>0-19</td>
<td>285,064 (0.8)</td>
<td>15,160 (0.5)</td>
<td>86,507 (0.4)</td>
</tr>
<tr>
<td>20-39</td>
<td>6,775,915 (18.5)</td>
<td>596,273 (18.8)</td>
<td>2,643,137 (12.3)</td>
</tr>
<tr>
<td>40-59</td>
<td>19,175,389 (52.5)</td>
<td>539,041 (17.3)</td>
<td>3,457,567 (16.1)</td>
</tr>
<tr>
<td>60-79</td>
<td>8,930,724 (24.4)</td>
<td>945,316 (30.4)</td>
<td>12,914,363 (60.3)</td>
</tr>
<tr>
<td>80+</td>
<td>1,391,144 (3.8)</td>
<td>1,026,239 (33.0)</td>
<td>2,319,469 (10.8)</td>
</tr>
</tbody>
</table>
## Effectiveness - ChAdOx1 nCov-19

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age group</th>
<th>At least first dose</th>
<th>Fully immunized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Severe cases/deaths</td>
<td>Deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Est. (95% Crl)</td>
<td>Est. (95% Crl)</td>
</tr>
<tr>
<td>ChAdOx1 nCov-19</td>
<td>20-39</td>
<td>59.4 (57.4--61.3)</td>
<td>69.8 (64.6--74.5)</td>
</tr>
<tr>
<td></td>
<td>40-59</td>
<td>65.0 (64.3--65.6)</td>
<td>72.7 (71.4--74.0)</td>
</tr>
<tr>
<td></td>
<td>60-79</td>
<td>63.9 (63.4--64.4)</td>
<td>74.5 (73.8--75.2)</td>
</tr>
<tr>
<td></td>
<td>80+</td>
<td>26.9 (25.6--28.3)</td>
<td>38.4 (36.7--40.0)</td>
</tr>
</tbody>
</table>
## Effectiveness CoronaVac

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age group</th>
<th>At least first dose</th>
<th></th>
<th></th>
<th>Fully immunized</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Severe cases/deaths</td>
<td>Est. (95% CrI)</td>
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<td>Severe cases/deaths</td>
<td>Est. (95% CrI)</td>
<td>Est. (95% CrI)</td>
</tr>
<tr>
<td>CoronaVac</td>
<td>20-39</td>
<td>48.5 (46.2–50.7)</td>
<td>72.5 (67.5–77.1)</td>
<td></td>
<td>58.4 (56–60.7)</td>
<td>81.5 (76.6–85.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40-59</td>
<td>65.1 (64.1–66.2)</td>
<td>76.1 (74.2–77.9)</td>
<td></td>
<td>71.0 (69.8–72.1)</td>
<td>82.7 (80.7–84.6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60-79</td>
<td>50.2 (49.7–50.6)</td>
<td>58.9 (58.2–59.5)</td>
<td></td>
<td>60.4 (59.9–60.9)</td>
<td>71.2 (70.6–71.9)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80+</td>
<td>21.8 (20.7–23)</td>
<td>33.2 (31.7–34.6)</td>
<td></td>
<td>29.6 (28.5–30.8)</td>
<td>45.0 (43.6–46.4)</td>
<td></td>
</tr>
</tbody>
</table>
Effectiveness BNT162b2

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age group</th>
<th>At least first dose</th>
<th>Fully immunized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Severe cases/deaths</td>
<td>Deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Est. (95% Crl)</td>
<td>Est. (95% Crl)</td>
</tr>
<tr>
<td>BNT162b2*</td>
<td>20-39</td>
<td>64.7 (59.8--69.3)</td>
<td>86.1 (76.9--93.8)</td>
</tr>
<tr>
<td></td>
<td>40-59</td>
<td>81.2 (79.9--82.4)</td>
<td>89.9 (87.8--91.8)</td>
</tr>
<tr>
<td></td>
<td>60-79</td>
<td>81.6 (78.3--84.6)</td>
<td>89.6 (85.1--93.2)</td>
</tr>
<tr>
<td></td>
<td>80+</td>
<td>33.0 (-10.7--55.1)</td>
<td>8.6 (-67.9--59.6)</td>
</tr>
</tbody>
</table>

*Not evaluated in fully immunized*
Incidence by age groups
Confounders and other factors

- Vaccination followed priorities given by descending order of age, comorbidities, vulnerable groups (indigenous peoples), healthcare workers
- Bias in young adults of healthcare workers
- Elderly received CoronaVac in the early phase (as early as February for two doses)
  - For ChAdOx1 completion of two-doses was generally more recent (due to larger 12 month interval)
- Attitude towards transmission during the pandemic has been changing in the whole population
- Incidence varied over time
Vaccination and the elderly

- Immunosenescence
- Potential loss of immunity over time
- These age groups completed full regimen earlier
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https://www.medrxiv.org/content/10.1101/2021.09.10.21263084v1
Final comments

- Massive data analysis
  - We intend to analyze datasets as vaccination advances
  - Results shared with Ministry of Health (ad-hoc technical committee)
- Effectiveness varied over age groups, regions

Next plans
- Formal analysis of effectiveness over time (after vaccination)
- Booster doses
- Heterologous vaccination
- Vulnerable groups
Team

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Parceria e apoio
GT-Influenza/PNI/Min. Saúde

CNPq
Thank you!

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https://www.medrxiv.org/content/10.1101/2021.09.10.21263084v1

PROCC: https://portal.fiocruz.br/programa-de-computacao-cientifica