On statistical modeling of Covid-19 mobility and health data

Prof Ron Kenett

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https://www.neaman.org.il/EN/Statistical-analysis-of-Corona-data-A-Roundtable

מוסד שמואל נאמן
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Statistical analysis of Corona data: A Roundtable

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The Role of Statisticians in the Response to COVID-19 in Israel: A Holistic Point of View

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Acknowledging the role statisticians should take in decision-making processes related to COVID-19, a round table organized by three past presidents of the Israel Statistical Association, and hosted by the Samuel Neaman Institute, took place on 13.4.2021. The meeting was designed to provide a forum for discussion and exchange of ideas on the profession's role during the COVID-19 pandemic, and more generally on its influence in promoting evidence-based public policy. The main outcome was the understanding that for statisticians to have a significant impact, they must be actively present in decision-making domains and especially in the strategic ones. This paper builds on the insights and discussions of that round table and presents a general framework with recommendations.

In the months following the round table, and in part inspired by the discussion there, a dramatic change has occurred in the role filled by statisticians in support of evidence-based decision-making by the Israeli Ministry of Health. A group of statisticians, data scientists and mathematicians has formed in order to analyze data regarding different aspects of the Israeli vaccination campaign.

Together with high official members of the Ministry, the group has tackled several complex issues. The first project was to try to determine the protection of individuals who recovered from COVID-19 compared to others, both unvaccinated and vaccinated.

The statistical analysis revealed that recovered individuals are protected in a similar fashion to individuals recently vaccinated with two doses. A second task, which required professional statistical analysis, was to determine the level of vaccine breakthrough of the Beta variant of concern. The analysis demonstrated that, despite the concerns caused by the Beta variant, the vaccine provides good immunity against it.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

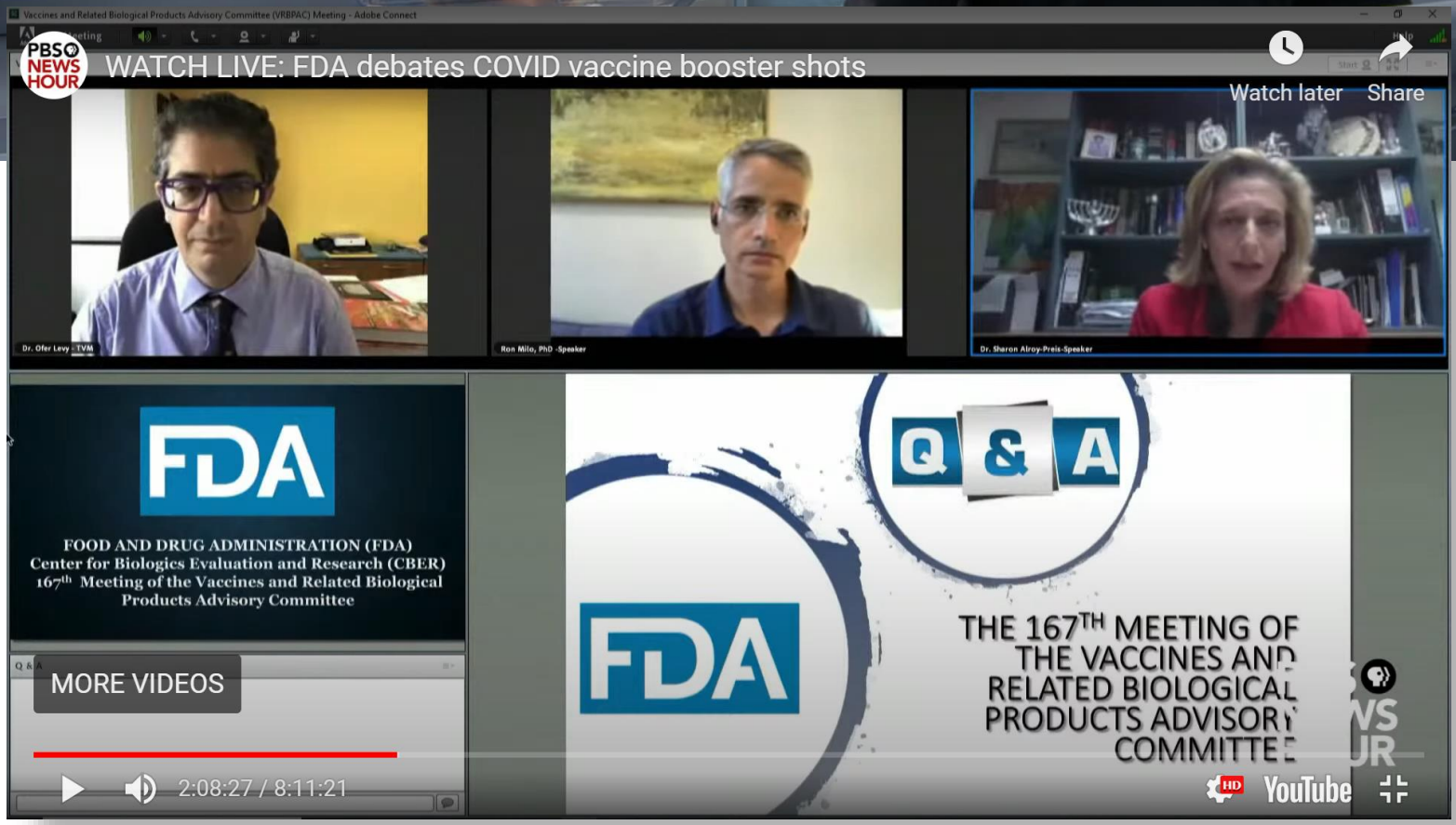
Protection of BNT162b2 Vaccine Booster against Covid-19 in Israel

Yinon M. Bar-On, M.Sc., Yair Goldberg, Ph.D., Micha Mandel, Ph.D., Omri Bodenheimer, M.Sc., Laurence Freedman, Ph.D., Nir Kalkstein, B.Sc., Barak Mizrahi, M.Sc., Sharon Alroy-Preis, M.D., Nachman Ash, M.D., Ron Milo, Ph.D., and Amit Huppert, Ph.D.

ABSTRACT

BACKGROUND

On July 30, 2021, the administration of a third (booster) dose of the BNT162b2 messenger RNA vaccine (Pfizer–BioNTech) was approved in Israel for persons who were 60 years of age or older and who had received a second dose of vaccine at least 5 months earlier. Data are needed regarding the effect of the booster dose on the rate of confirmed coronavirus 2019 disease (Covid-19) and the rate of severe illness.



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https://www.researchsquare.com/article/rs-892584/v1?fbclid=IwAR1V76YsOh20bQw7us6an5EnzrpxLRJUVSD4o8jzxj8vClyK-5MOD0QBN-c

Integrated Analysis of Behavioral and Health Data: A Comparative Study of COVID19 Data in Israel and Italy

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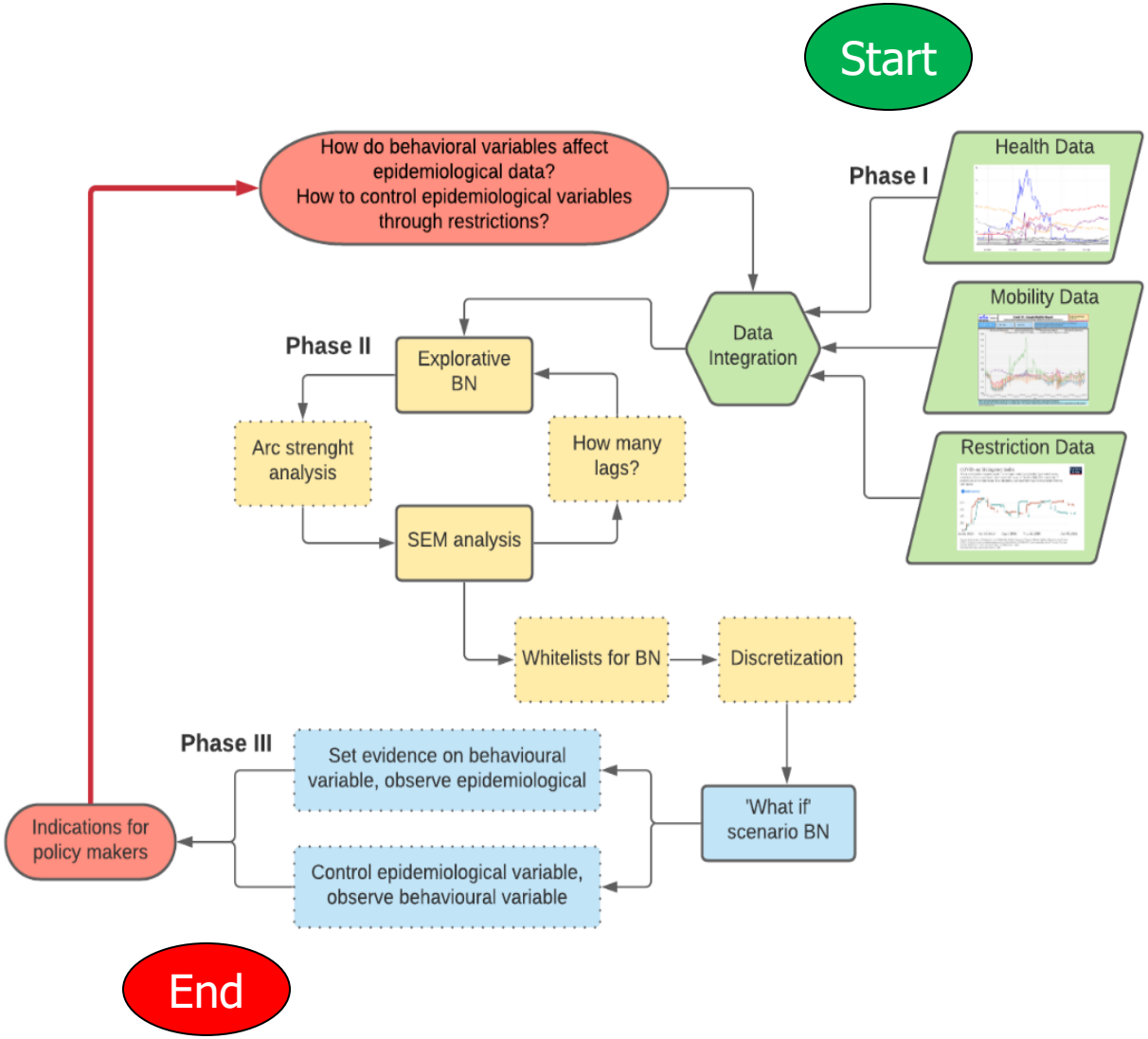
ABSTRACT

The response to the COVID19 pandemic has been highly variable, both in terms of between-nations variation and within the same nation, at different waves. In this context, governments applied different mitigation policy responses with varying impact on social and economic measures over time. This article examines the effect of mobility restriction measures in Italy and Israel and compares the association between health and population mobility data. Facing the pandemic, Israel and Italy implemented different policy measures and experienced different public activity patterns. The analysis we conducted is a staged approach using Bayesian Networks and Structural Equations Models to investigate these patterns. The goal is to assess the impact of pandemic management and mitigation policies on pandemic spread and population activity. We propose a methodology that first models data from health registries and Google mobility data and then shows how decision makers can conduct scenario analysis to help support pandemic management policies.

Methodology

1. We collected data on health and population behavior from ministries of health and google mobility
2. We integrated the data using Bayesian networks and determined proper lags using arc strength indicators.
3. The derived network structure was assessed using confirmatory SEM.
4. We then discretized the data accounting for local thresholds and used the resulting BNs to assess alternative scenarios. For example: what would be the impact of closing airports?
5. The data from Italy and Israel was calibrated using “wave” time windows and using country based thresholds.
6. The fact that we did this in two countries, in parallel, proved very effective from a methodology viewpoint.

Methodology



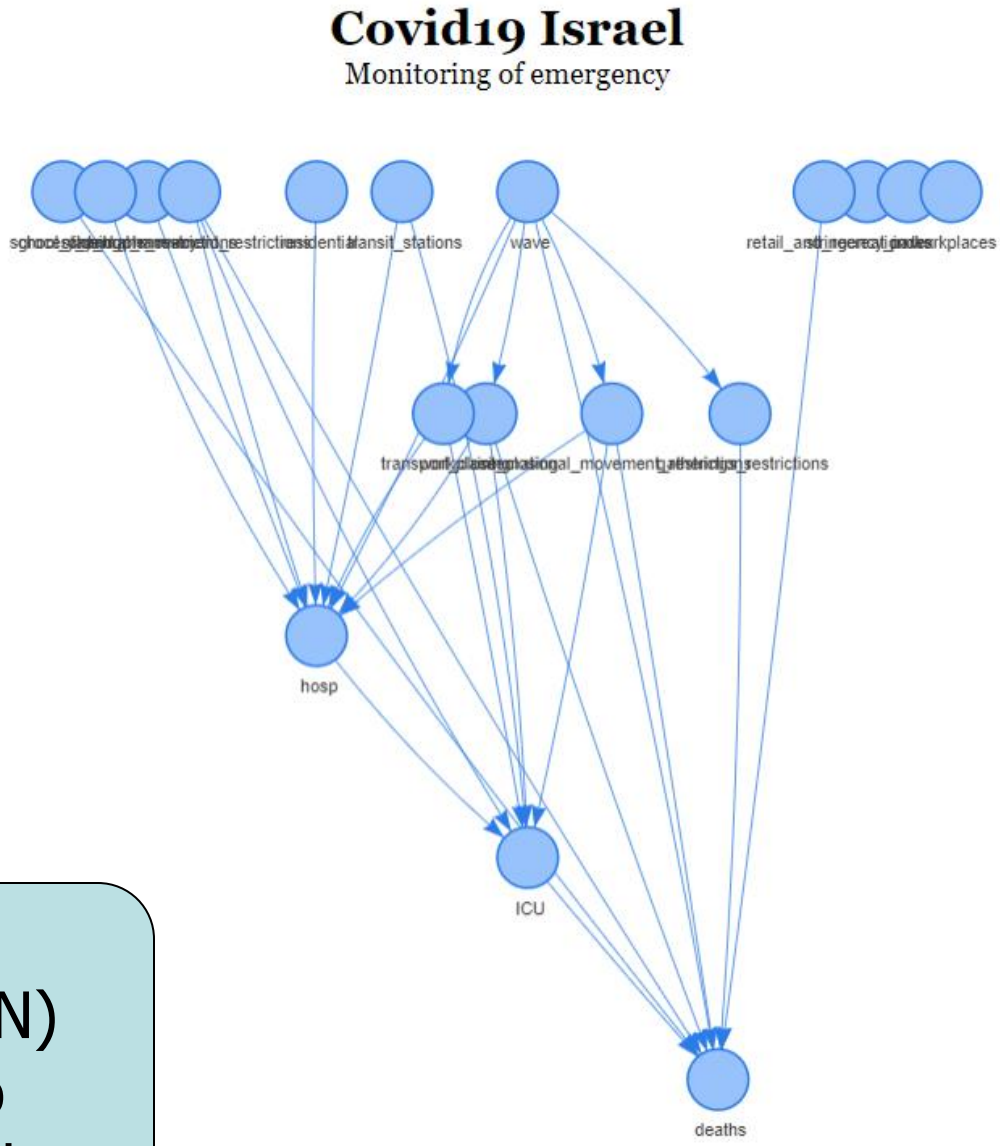
Goal: Provide decision makers with a decision support system

Phase I: Map data sources, integrate data

Phase II: Analyze data to determine multivariate structure

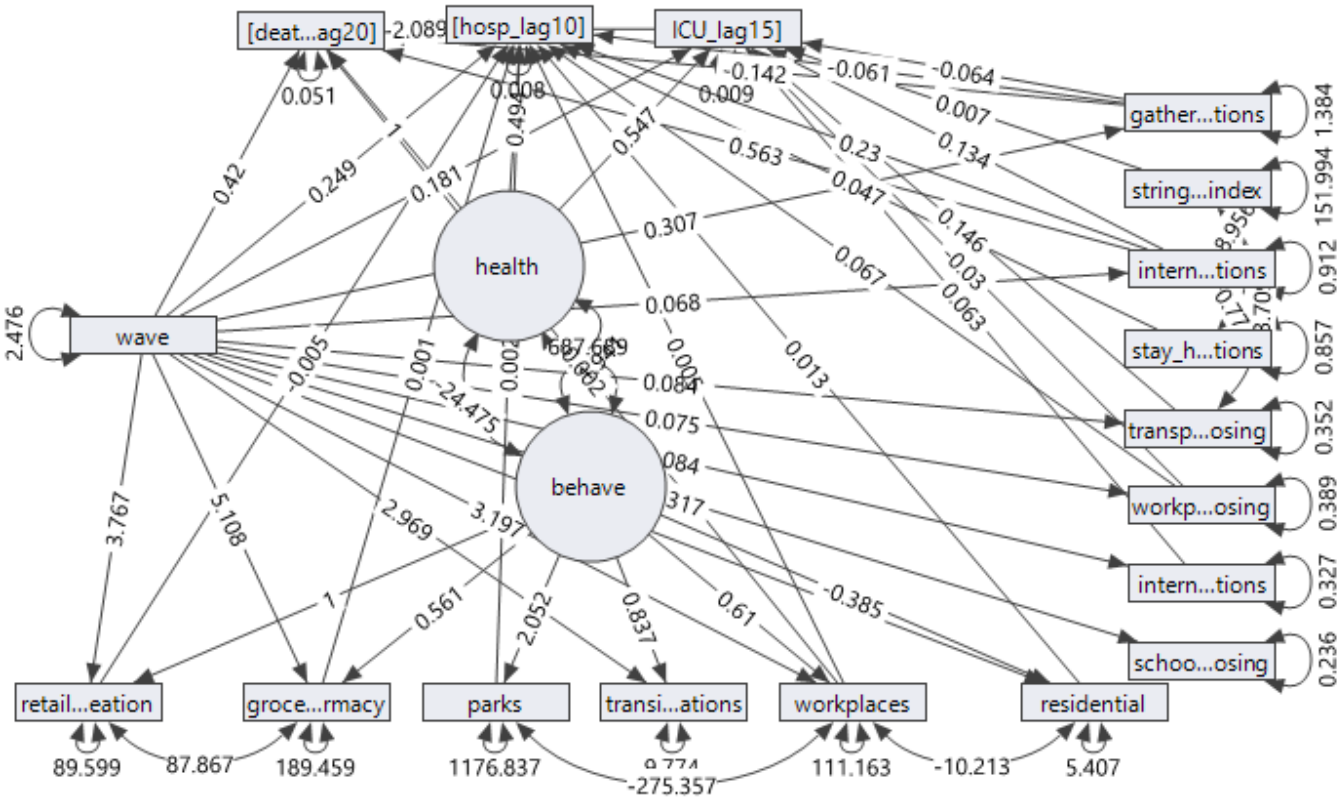
Phase III: Operationalize model to support decision makers with predictive and diagnostic capabilities

https://tinyurl.com/rbexhtww.



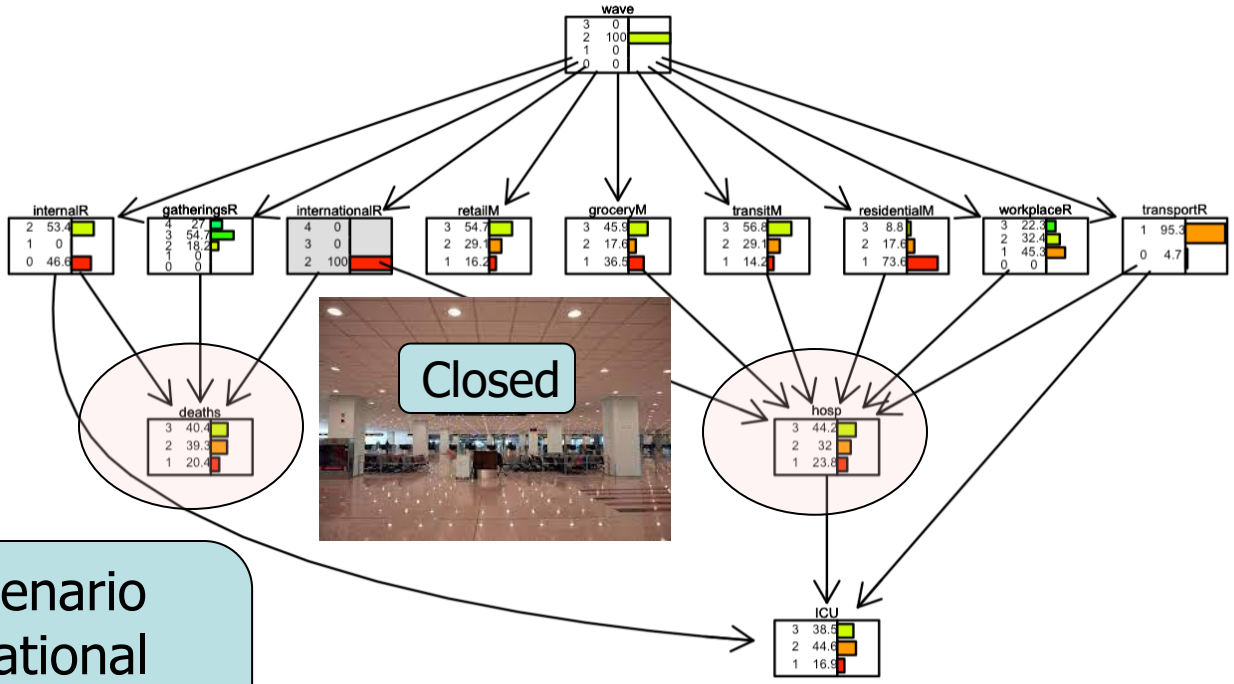
Hosp Lag 10, ICU Lag 15, Deaths Lag 20

Bayesian Network (BN) analysis to establish links

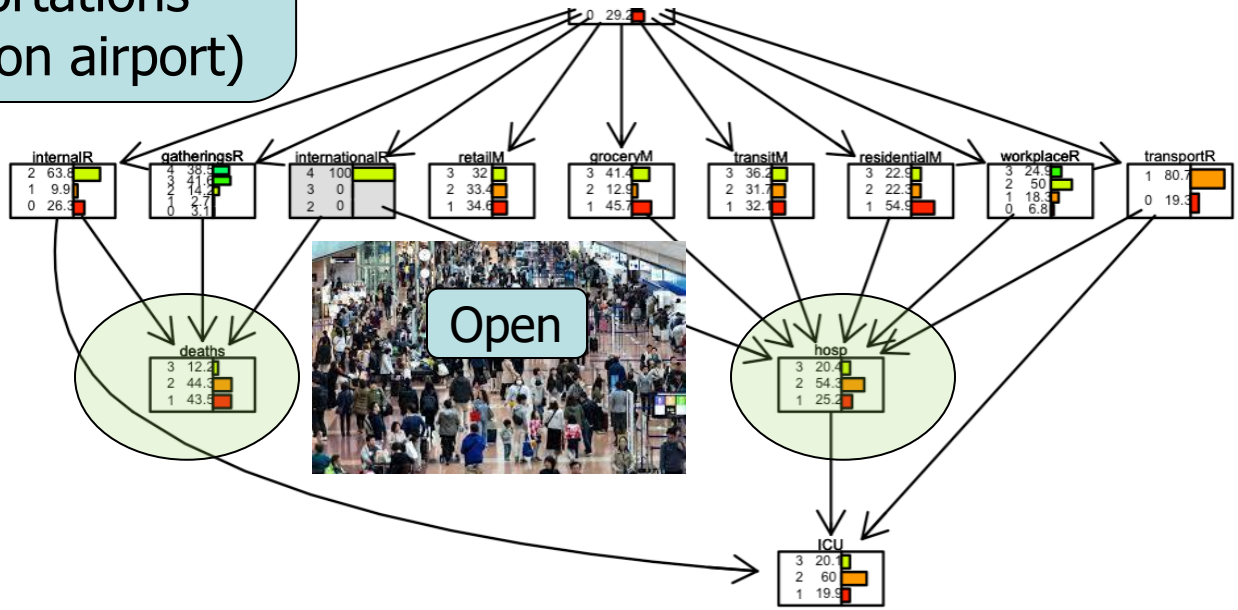


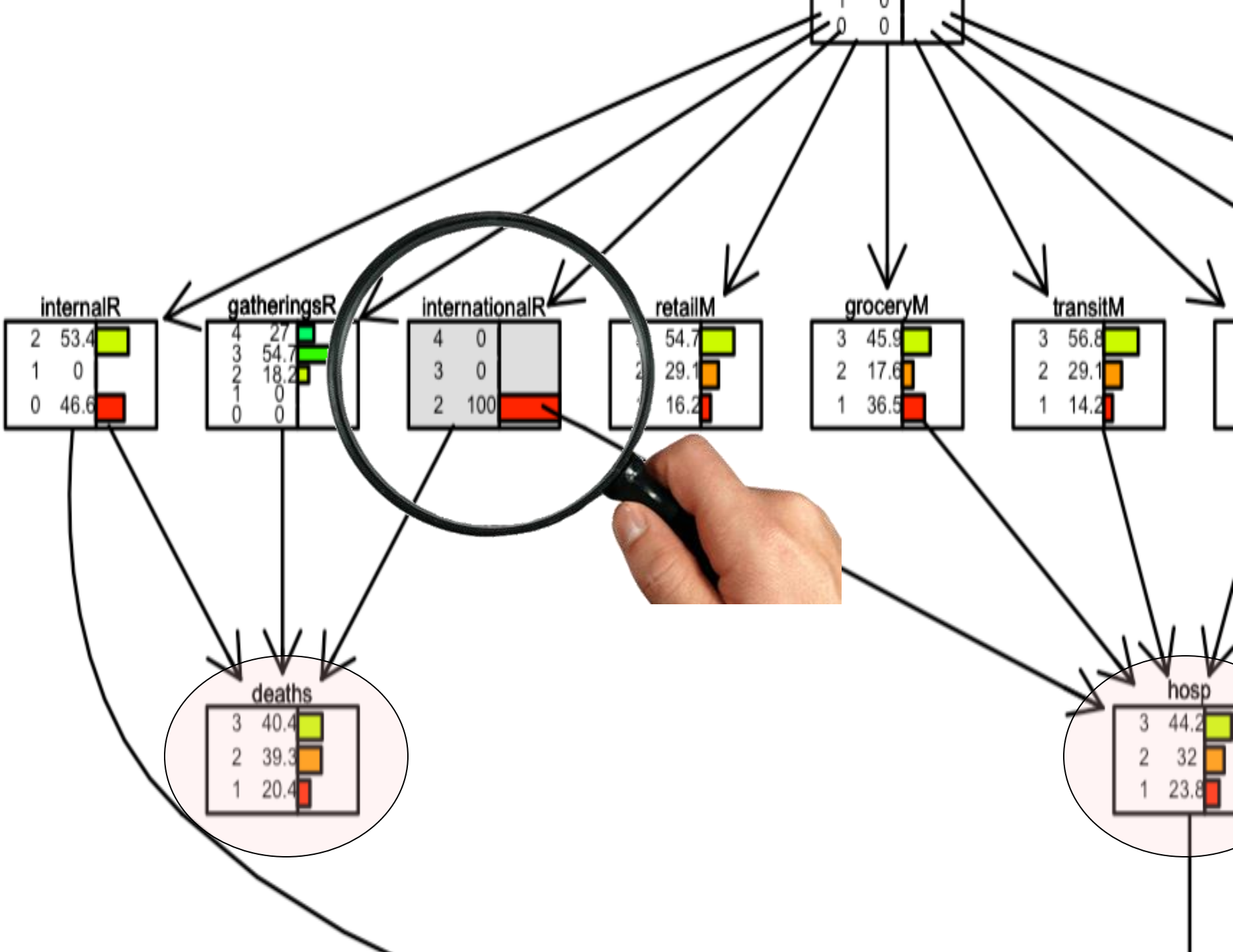
Structural Equation Models (SEM) to confirm links

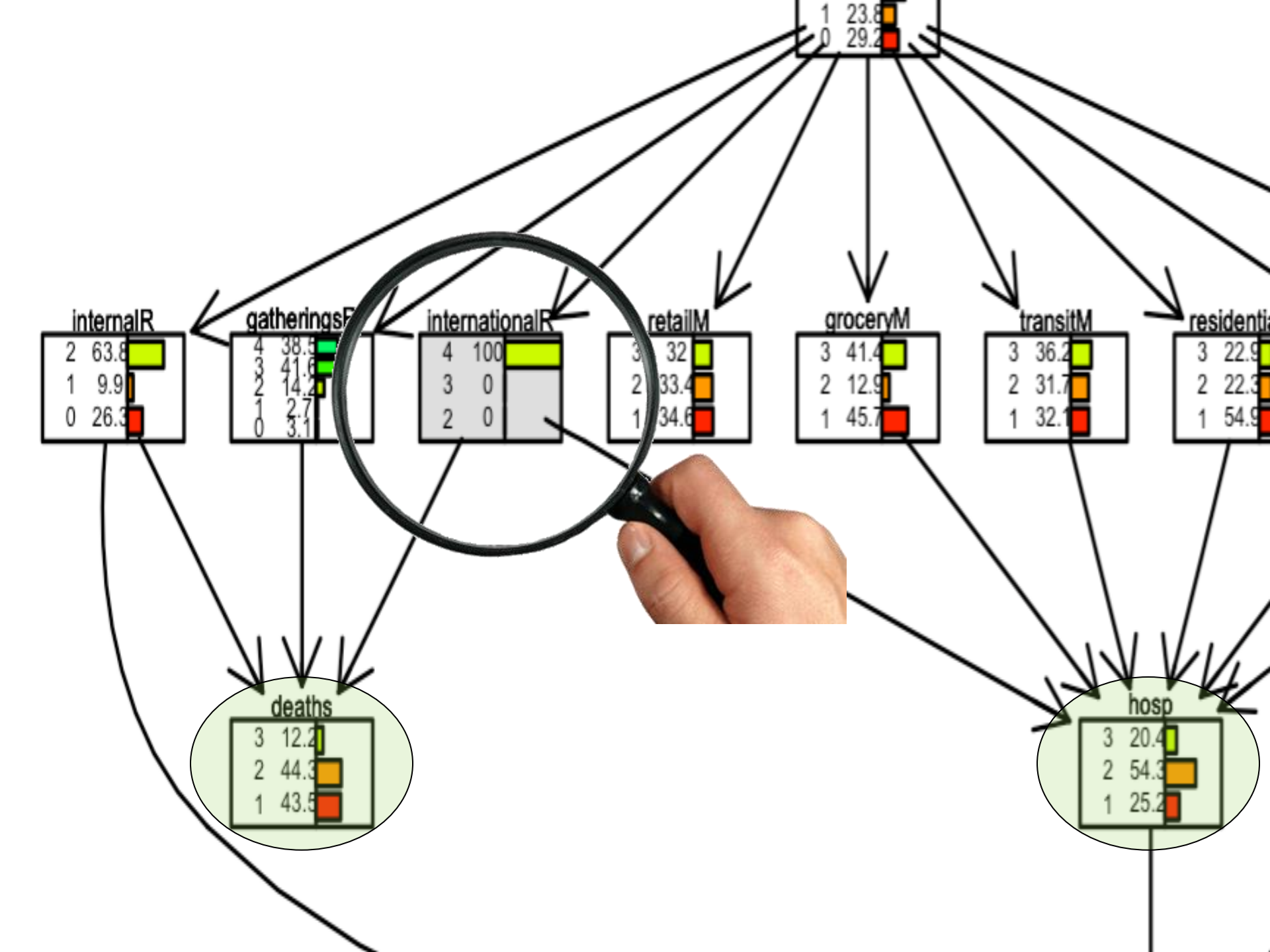
Regressions	Estimate	SE	Prob>|Z|
workplaces → [hosp_lag10]	0.0051733	0.0013351	0.0001*
workplaces → [death_lag20]	-0.001852	0.0012394	0.1350
workplace_closing → [icu_lag15]	-0.030367	0.0278552	0.2756
workplace_closing → [hosp_lag10]	0.0667816	0.0270191	0.0134*
wave → workplaces	3.19686	0.5874759	<.0001*
wave → workplace_closing	0.0754524	0.0217294	0.0005*
wave → transport_closing	0.0837236	0.0126287	<.0001*
wave → transit_stations	2.9688032	0.4265175	<.0001*
wave → [icu_lag15]	0.1807456	0.0274846	<.0001*
wave → [hosp_lag10]	0.2486583	0.0245819	<.0001*
wave → [death_lag20]	0.4204896	0.1221507	0.0006*
wave → school_closing	-0.316598	0.0169194	<.0001*
wave → retail_and_recreation	3.7666174	0.59323	<.0001*
wave → residential	-1.129711	0.2063731	<.0001*
wave → international_movement_restrictions	0.0842087	0.0199013	<.0001*
wave → internal_movement_restrictions	0.0676107	0.0158063	<.0001*
wave → grocery_and_pharmacy	5.10812	0.5543045	<.0001*
wave → gatherings_restrictions	0.3068871	0.0409729	<.0001*
transport_closing → [icu_lag15]	0.1455176	0.0273859	<.0001*
stringency_index → [icu_lag15]	0.0067435	0.0038163	0.0772
stay_home_restrictions → [hosp_lag10]	0.0472529	0.022111	0.0326*
[icu_lag15] → [death_lag20]	1.1659765	0.2939227	<.0001*
[hosp_lag10] → [death_lag20]	-2.089182	0.410195	<.0001*
retail_and_recreation → [hosp_lag10]	-0.005147	0.0014207	0.0003*
residential → [hosp_lag10]	0.013011	0.004218	0.0020*
parks → [hosp_lag10]	0.0019993	0.0004296	<.0001*
international_movement_restrictions → [icu_lag15]	0.0630446	0.018092	0.0005*
internal_movement_restrictions → [icu_lag15]	0.1338373	0.0667171	0.0449*
internal_movement_restrictions → [hosp_lag10]	0.230179	0.0574105	<.0001*
internal_movement_restrictions → [death_lag20]	0.5626452	0.1869919	0.0026*
grocery_and_pharmacy → [hosp_lag10]	0.000544	0.0008651	0.5294
gatherings_restrictions → [icu_lag15]	-0.063505	0.0407235	0.1189
gatherings_restrictions → [hosp_lag10]	-0.061278	0.035522	0.0845
gatherings_restrictions → [death_lag20]	-0.141549	0.0740964	0.0561
Covariances	**Estimate**	**SE**	**Prob>|Z|**
behave ↔ health	-24.47497	8.5668423	0.0043*
grocery_and_pharmacy ↔ retail_and_recreation	87.867134	9.2979598	<.0001*
residential ↔ workplaces	-10.21344	1.4937324	<.0001*
stay_home_restrictions ↔ internal_movement_restrictions	0.7703725	0.0643261	<.0001*
stringency_index ↔ internal_movement_restrictions	8.9560929	0.7747634	<.0001*
stringency_index ↔ stay_home_restrictions	8.8102202	0.7537571	<.0001*
stringency_index ↔ transport_closing	3.708656	0.3479073	<.0001*
workplaces ↔ parks	-275.3571	24.166104	<.0001*



What if scenario on international Transportations (Ben Gurion airport)




internalR
2 53.4
1 0
0 46.6
gatheringsR
4 27
3 54.7
2 18.2
1 0
0 0
internationalR
4 0
3 0
2 100
retailM
54.7
29.1
16.2
groceryM
3 45.9
2 17.6
1 36.5
transitM
3 56.8
2 29.1
1 14.2
deaths
3 40.4
2 39.3
1 20.4
hosp
3 44.2
2 32
1 23.8


1 23.8
0 29.2
internalR
2 63.8
1 9.9
0 26.3
gatheringsR
4 38.5
3 41.6
2 14.2
1 2.7
0 3.1
internationalR
4 100
3 0
2 0
retailM
3 32
2 33.4
1 34.6
groceryM
3 41.4
2 12.9
1 45.7
transitM
3 36.2
2 31.7
1 32.1
residenti
3 22.9
2 22.3
1 54.9
deaths
3 12.2
2 44.3
1 43.5
hosp
3 20.4
2 54.3
1 25.2

	ITALY			ISRAEL	
hosp	<5000	>15000	>30000	<250	>1100
icu	<200	>2000		<40	>150
deaths	<100	>500		<5	>20

Thank you for your attention

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