# Social & Special Landscape of COVID-19 Immunity in Denmark

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## Extended Abstract

Denmark maintained one of the lowest excess-mortality rates in Europe during the COVID-19 pandemic. This outcome coincided with high vaccination coverage and an unparalleled, routine, digital testing program. With these data now linked at the individual level [1, 2], we can evaluate the effectiveness of interventions while explicitly accounting for who gets tested, when, and how often. In this work, we focus on vaccination: we measure uptake, public response, and the networked pathways through which individual behavior shapes population outcomes.

In Denmark, vaccination and testing uptake were shaped by clear gradients: unvaccinated individuals were disproportionately young, male, lower-income, and of non-native background. Many in these groups never tested or tested only once, creating blind spots precisely where infection risk was higher. Positivity rates remained systematically higher among the unvaccinated across testing intensities, a pattern not fully explained by direct vaccine protection alone and consistent with differential exposure and social sorting.

Kinship, household, school, and workplace ties revealed strong assortativity in vaccination status. Where compliance clusters socially or spatially, indirect protection (the spillover benefit to neighbors) thins, and pockets of susceptibility persist even under high average coverage. Network models further indicate counterintuitive spillovers: partial segregation between compliant and non-compliant groups can increase infections within the compliant group by allowing non-compliant clusters to act as high-intensity reservoirs that seed transmission across the remaining bridges.

Beyond demography, preliminary analyses of personality measures (HEXACO and related constructs [3]) suggest modest but coherent associations: conscientiousness, agreeableness, and extraversion correlate with higher vaccination and testing, while social dominance and risk-taking align with lower uptake. Fig. 1 shows such associations. These patterns are consistent with the idea that epidemic responses are filtered through social identity, trust, and values—helping explain why compliance clusters along both social and psychological dimensions.

Denmark's registry-linked testing, vaccination, and genomic infrastructure offers unprecedented resolution on epidemic dynamics—but it also exposes systematic gaps. Under-testing and under-vaccination concentrate in identifiable social and spatial niches that are reinforced by homophily, limiting the reach of otherwise effective interventions. The central challenge, therefore, is not only to estimate biological efficacy but to quantify how interventions diffuse across real social networks under behavior-dependent observation.

Our findings underscore three design principles for future preparedness: (i) behavior-aware inference that adjusts for shifting access and motivations to test; (ii) network-targeted strategies that disrupt reservoirs and strengthen cross-type ties where compliance is sparse; and (iii) equity-first implementation that addresses socioeconomic barriers to participation. Only by confronting clustered compliance—and the visibility bias it creates—can public health sustain epidemic control when average coverage is high but unevenly distributed.

# References

[1] Mark P Khurana et al. "High-resolution epidemiological landscape from˜ 290,000 SARS-CoV-2 genomes from Denmark". In: *Nature communications* 15.1 (2024), p. 7123.

[2] Jolien Cremers et al. "Unveiling the social fabric through a temporal, nation-scale social network and its characteristics". In: *Scientific Reports* 15.1 (2025), p. 18383.

[3] Ingo Zettler et al. "The Nomological Net of the HEXACO Model of Personality: A Large-Scale Meta-Analytic Investigation". In: *Perspectives on Psychological Science* 15.3 (2020), pp. 723–760. URL: https://doi.org/10.1177/1745691619895036.

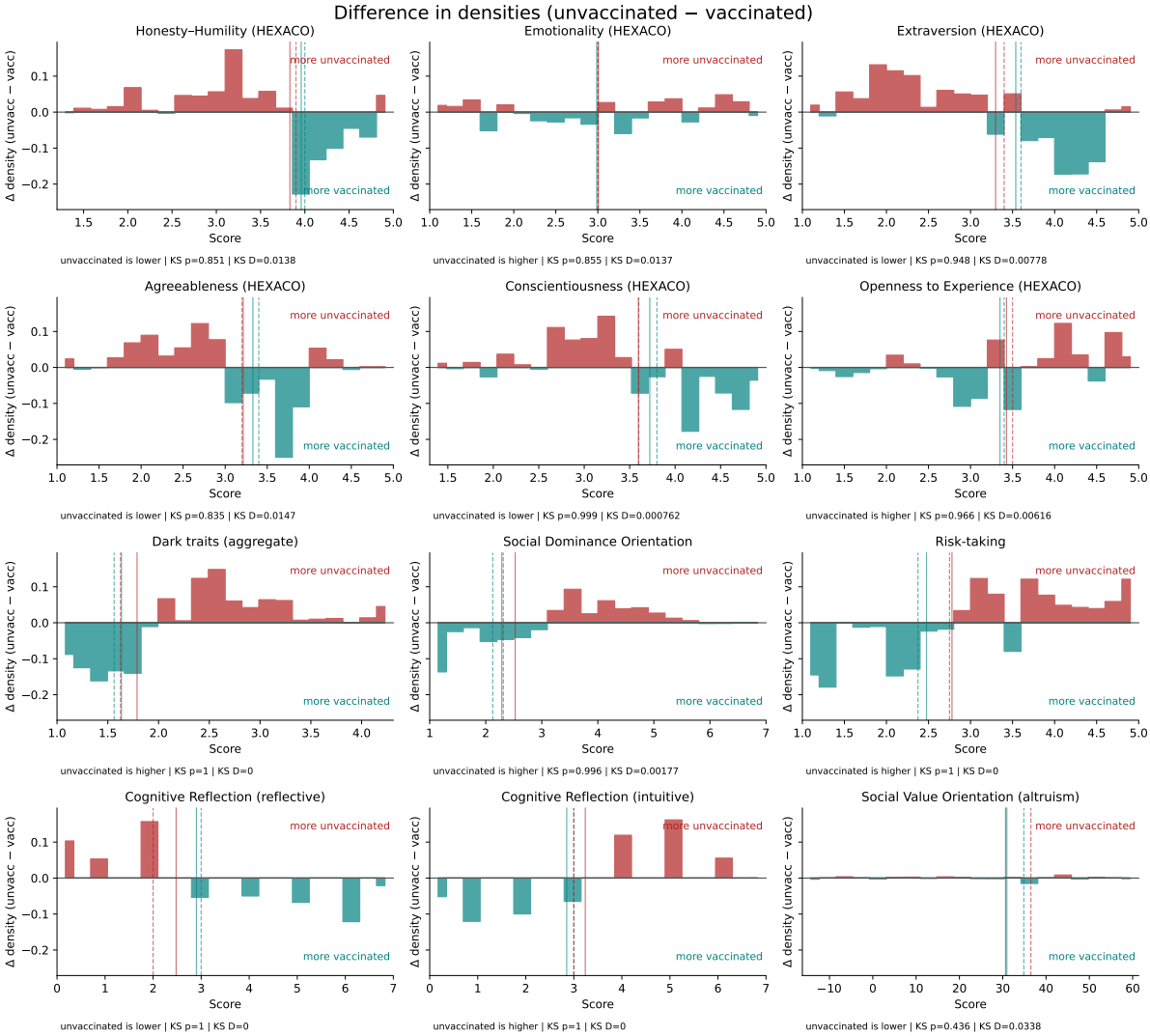


Figure 1: **Personality, values, and cognitive style by vaccination status (Denmark).** Vaccinated score higher on Honesty–Humility/Agreeableness (trust/cooperation), Extraversion, Conscientiousness, prosocial orientation, and cognitive reflection; unvaccinated score higher on risk-taking, Dark Triad traits, Social Dominance Orientation, intuitive response style, Emotionality (context-dependent), and Openness.