Medical Journal of Virtual Science

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

Research

Entropy considerations on COVID 19 pandemics in Germany, 2020-2021

Maurice Weber [1)], Norbert Rottmann [2)], Fang Wei-Kleiner [1)], Stephan Borkenfeld [3)], Klaus Kayser [3)]

1) Institut für Informatik, Albert-Ludwigs-Universität Freiburg, Germany,

✉: maur.ice.weber@icloud.com,

✉:fwei@informatik.uni-freiburg.de

2) ✉: norbert.rottmann@protonmail.com

3) Verein Förderung des biologisch – technologischen Fortschritts in der Medizin e.V., Heidelberg, Germany,

✉: s.borkenfeld@web.de,

✉: Klaus.kayser@ki-universum.de

Abstract:

Aims: To describe and analyze Shannon and structural (MST) entropy of COVID-19 pandemics in Germany for 61 months (2020 – 2021).

Material and Methods: The officially published number of infected persons, incidence and number of corona – associated deaths in the Federal Republic of Germany during the period February 28, 2020 – March 15, 2021 underwent thorough verification and detailed computation in relation to the involved public health center, date of publication, and consistency of data. Shannon entropy and structural (MST) entropy were derived from these data and associated with the health center's location, covered population and week of publication. Python programs and self - written programs based upon DIAS (Digital Image Analysis Software (1)) served for information analysis of the COVID pandemics.

Results: A total of 2,444,615 infected persons were included in the study, and 70,104 persons died because of or in association with the infection. Distance analysis between the different health centers revealed a time delay of 10 weeks of potential virus jump between the centers. The 'hot spots' of the infection were associated with the distance of the health centers from the Republic boundaries to its neighboring countries. No association of spread velocity and

Medical Journal of Virtual Science

 Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

death rate was found with the size of the health centers' community and their environment (big cities, rural towns, etc.).

Interpretation: The results indicate that the well-known general features of COVID pandemics, namely distance related risk factors play a major role at the country's borders. Population density and life conditions are of lower impact. The entropy model is a useful tool to describe and analyze 'distance – associated alterations of social entities' such as pandemics and related hazards.

Keywords: COVID pandemics, Federal Republic of Germany, Shannon entropy, structural (MST) entropy, incidence, death rate.

***Introduction*:** COVID pandemics is a mRNA virus transmitted infection of the upper and lower airways (2-4). Different strains of virus are known and can be isolated by reduplicated Polymerase Chain Reaction (PCR) and associated antibody detection (5-8). Several protective agents (injections) are available, and approximately 60% of the adult population in Germany have received a principal protection (vaccination) in summer 2021 (3, 9, 10). COVID pandemic is a disease induced by an organism which involves the lowest biological structures in our body, i.e., compartments of cellular membranes and genetic material (nuclei, RNA, DNA). Therefore, direct virus inhibition, protection and treatment such as effective vaccination work at this level (3, 11-14).

In addition and without any doubt, COVID pandemic is a socially directed disease too. Protection against COVID infection also relies on the 'behavior' of the citizens, which is hard to direct and to arrange appropriately in Western democratic countries (3, 14-16). In addition to infected human body cells and organs of individual persons higher order 'social' structures such as labor, communication, trade, etc. are also seriously damaged (14, 17-19). Therefore, is seems to be of advantage to search for tools that accurately describe and analyze the damages of social structures. One promising tool is the principal entity in nature called entropy (20-24).

Theory of entropy application: Nature occurs in structures and functions (events) which can be embedded in a four dimensional space. It includes three reversible (spatial) and one irreversible (time) coordinates (22). The principle separation of descriptive coordinates from the content permits a highly independent projection of the space on the coordinates. For example, it permits calculations of the nature's likely development.

Entropy (S) is considered to be the principal entity that measures the direction of any systems development and the 'distance' form its final stage (23-26). It is a theoretical statistical measure of a system which consists of distinguishable individual elements (events) and distribution of their associated features.

Such a system has reached its final stage if its entropy (S) becomes a maximum. The principal (Shannon) formula holds $S = - \Sigma(p \ln p)$ (23-26).

The general prerequisites to apply entropy calculations of the system are minimum, and commonly only include only a limited set of distinguishable individual elements (21).

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

One might add the distance between neighboring elements to Shannon's Formula in order to calculate the internal 'heterogeneity', or spatial distribution of existent 'structures' during the period of 'observation' (measurement). One measure might be the distance to the nearest neighbor. It can be described by the corresponding formula

$S(MST) = - k * \Sigma(d_{is}* p_i \ln p_i)$. dis $= \{(d_i-d_{mean})/d_{mean}\}^2$.

The measure S(MST) has been reported to be a useful entity to predict the outcome of several biological systems, for example the survival of lung cancer patients (27-29).

Material and Methods: We are very grateful to the Robert Koch Institute, Berlin, the official Biomedical Research Facility of the Federal Republic of Germany to submit to us its COVID case collection for the period February 28, 2020 until to March 15, 2021.
By definition, a COVID case represents an infected PCR proven human person with or without presentation of symptoms.
The total of 401 registered public health centers was aggregated to 390 institutions because of partly overlapping areas of influence.
The collection contains a total of 1.048.574 data sets. The data include basic population census, location of the involved public health offices, areas of covered district, population density, detected COVID cases and COVID associated deaths during the period of investigation.
The collection data were analyzed using Excel / CSV data sheets, Python and self - written program based upon DIAS (Digital Image Analysis System, published by Tower Soft, Jena, 1995) (1).
Neighborhood calculations included graph theory algorithms such as Voronoi's tessellation and Minimum Spanning Tree computations (MST) (1) .
The applied algorithms include basic statistics such as chi-Square, univariate and multivariate correlation analysis, spatial applied time correlation / regression procedures and entropy calculations and use

A) Shannon entropy $S(SHA) = - k * \Sigma(p_i * \ln p_i)$, and
B) Structural (MST) entropy $S(MST) = - k * \Sigma(d_{is}* p_i \ln p_i)$
$d_{is} = \{(d_i-d_{mean})/d_{mean}\}^2$

The basically negative entropy calculations were transformed into corresponding positive data (multiplication by (-)) in order to allow an easier interpretation of the obtained graphs. The principle of the calculations remains unchanged.

The geographic area of Germany was stereologically projected on a 2096 X 2094 digital pixel matrix which served for visual presentation of the centers' position and borders of the Federal Republic of Germany.
The geographic location of all involved health centers was transferred in this representative x-y map of Germany. It served for illustration of incidence and dynamic case rates during the observation period.

Medical Journal of Virtual Science

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

The included 390 different public health centers were grouped in five categories, which include the cohorts

Big cities,	population > 500,000 inhabitants (N=21)
Main cities,	population > 300,000 inhabitants (N=45)
District government cities,	population > 200,000 inhabitants (N=72)
Rural administration towns,	population > 100,000 inhabitants (N=116)
Integrated villages, towns,	population < 100,000 inhabitants (N=136).

Results: The total of registered COVID cases amounts to 2,444,615 citizens, and to 70,104 COVID associated deaths within a total population 82,776,353 inhabitants. The incidence of COVID infections during the covered period is calculated 2,953 /100,000, the corresponding mortality 84,7 /100,000. Three out of 100 infected persons died (2,868 %).
The development of COVID infections and COVID associated deaths during the investigated period is depicted in <figure 1>. A delay of 5 – 8 weeks between the two curves is noted.

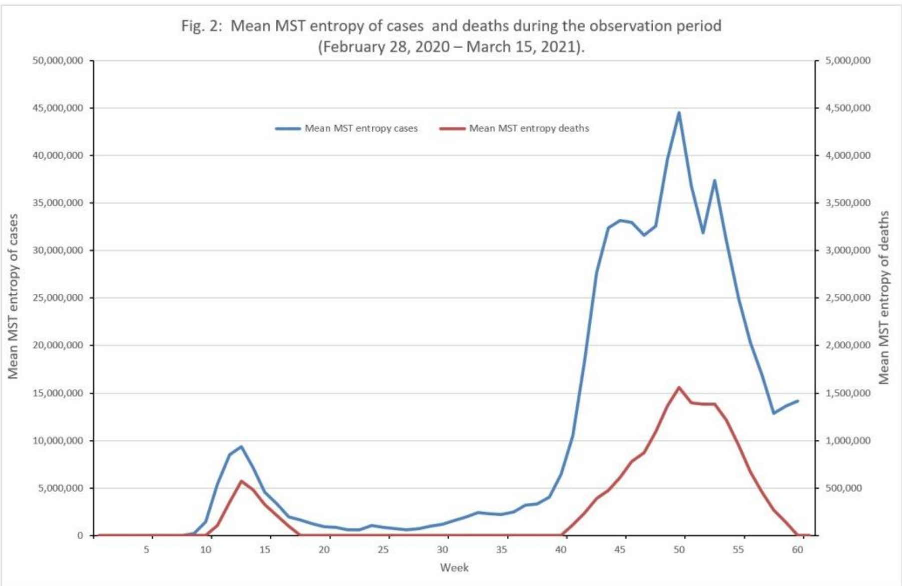

Figure 1: Crude numbers of cases (--)-; and deaths (---) during the observation period (February 28, 2020 – March 15, 2021.

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

The two associated MST entropy graphs display with the same delay <Figure 2>.

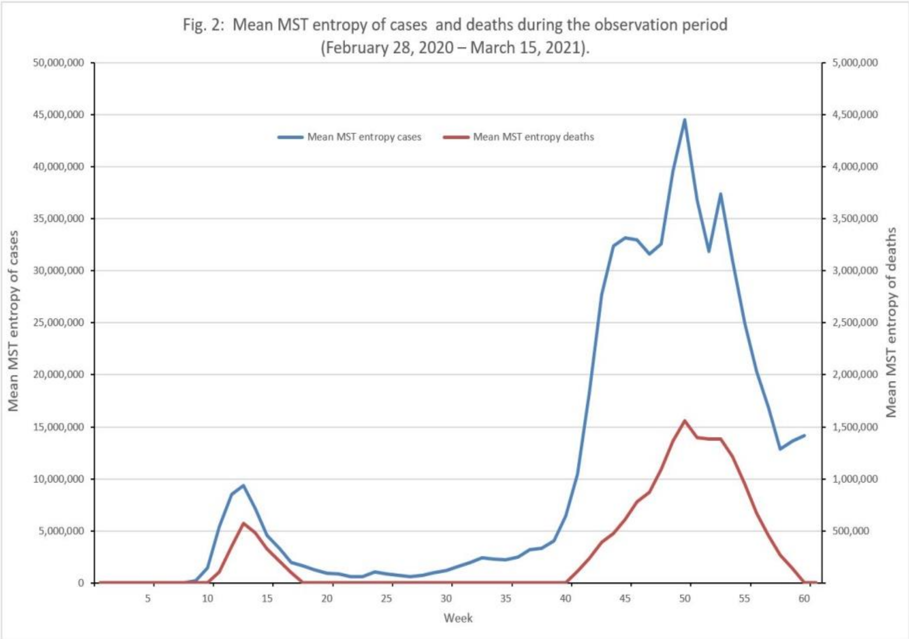

Figure 2: Mean MST entropy of cases (--)-; and deaths (---) during the observation period (February 28, 2020 – March 15, 2021.

A weak increase of the MST entropy appears already in the first week, and a sharp increase of infected persons after 10 weeks in a total of 61 weeks of investigation. The MST entropy of the associated deaths starts at week 9. Thus, a measurable neighborhood influence of public health centers (affiliation of infected persons) on the systems condition (pandemics of the republic) requires 5 - 9 weeks. The system's general condition does not change after this barrier and seems to stay in a nearly constant 'end stage'.
Which public health centers are involved, where are they located, and which type of public health center signals specific features?
<Figure 3 and figure 4> indicate the incidence (cases / health center class) <figure3> and mortality (deaths / health center class) <figure 4> grouped according to the type of health center during the period of investigation.

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

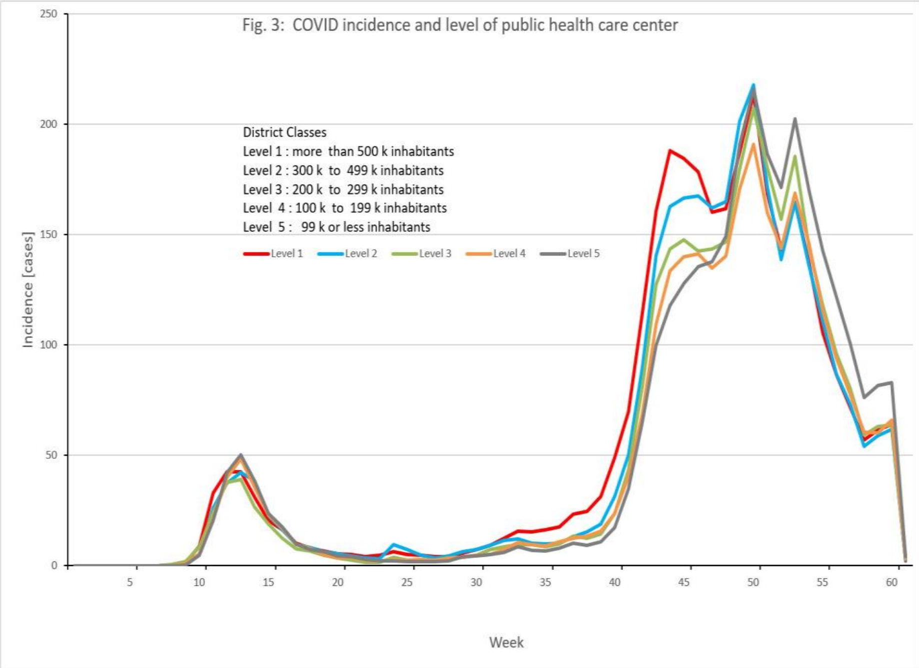

Figure 3: COVID incidence and level of public health care center.

Despite a slightly increased mortality in rural areas (class 5) the graphs display without significant differences between the different types of the health centers and permit the conclusion that the population density / environment are of no remarkable influence on incidence and mortality during the investigated period.

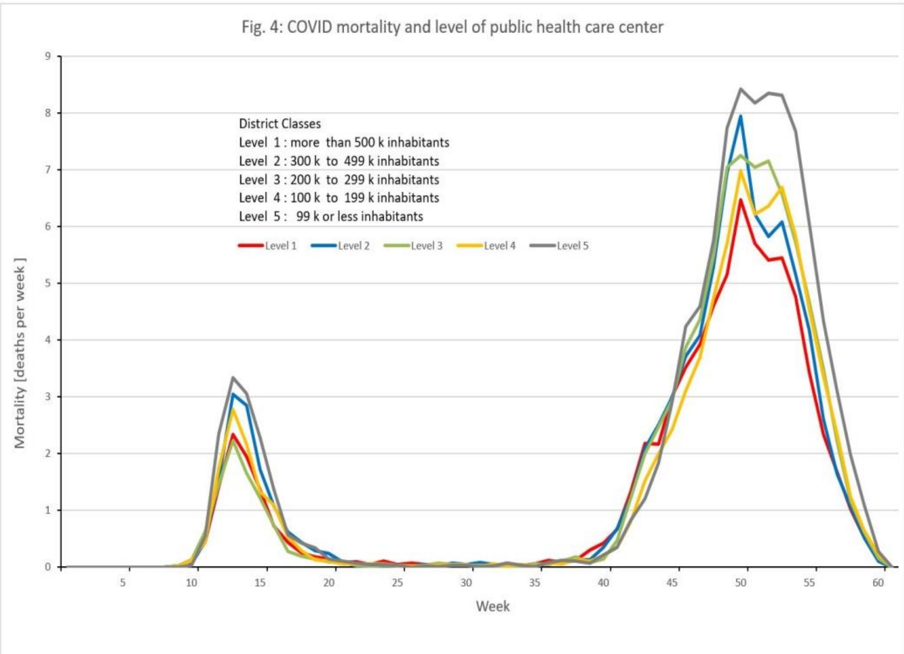

Figure 4: COVID mortality and level of public health care center.

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

The location of the public health centers in the Federal Republic of Germany and the measured COVID data are shown in <Figure 5 and figure 6>.

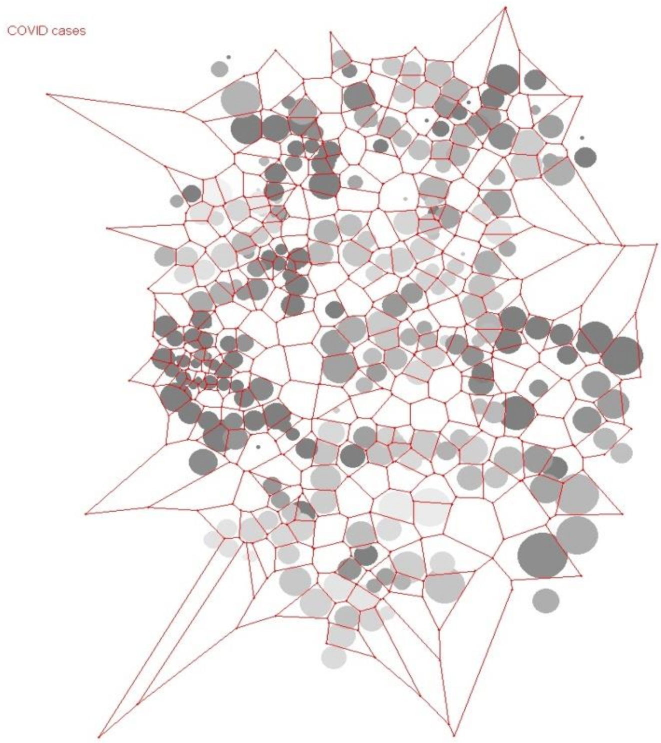

Figure 5: Map of German Public Health Centers and crude COVID case numbers, indicated, by gray value depth. (Note the clusters close to the Eastern and Western border.
The number of reported cases is indicated by the gray value (darkness) and the covered geographic area by the size of the marked circles.

Medical Journal of Virtual Science

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

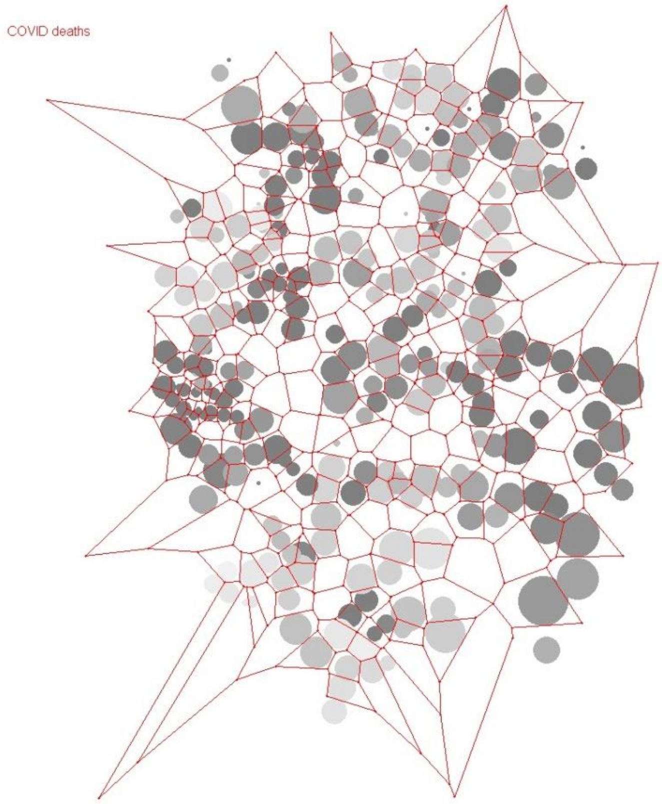

Figure 6: Map of German Public Health Centers and crude COVID deaths numbers, indicated by gray value depth. (Note: The clusters in Figure 5 close to the Eastern and Western border are less significant.

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

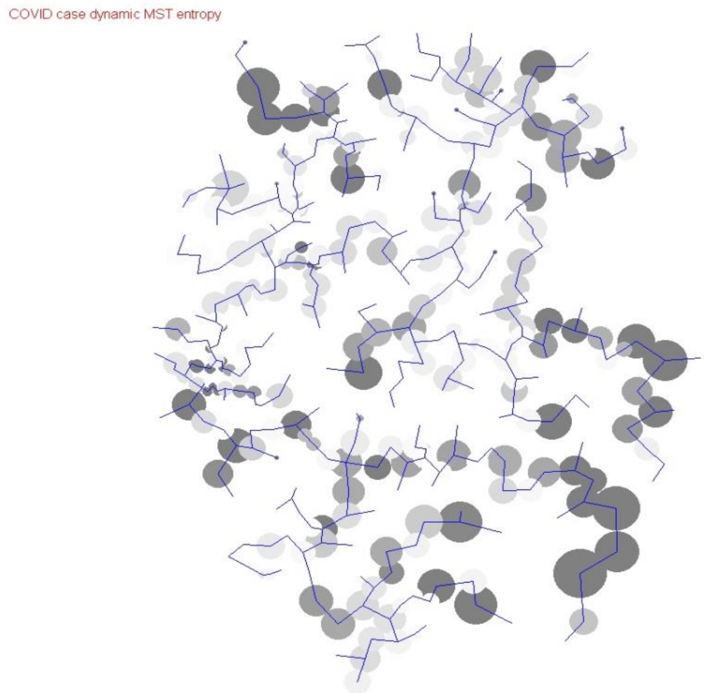

Figure 7: Map of German Public Health Centers and weekly difference of crude case numbers (dynamic development of pandemic during the observation period). Note the aggregation at the east – southern border (Czech Republic).

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

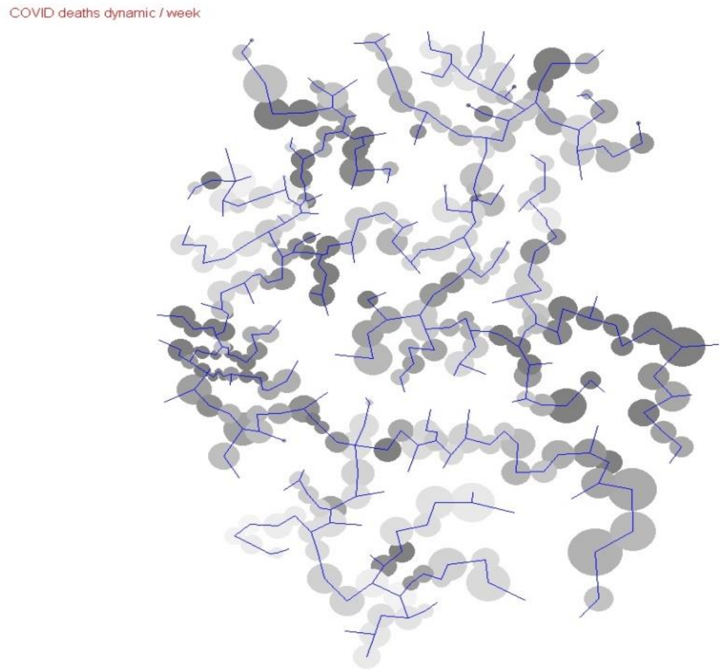

Figure 8: Map of German Public Health Centers and weekly difference of crude number deaths (dynamic development of pandemic deaths during the observation period). Note the 'shift' of the east – western aggregation to the north.

The most affected centers are grouped along the boundary of the Federal Republic, which is confirmed by calculation of MST- entropy and MST entropy dynamics between neighboring weeks. Thus intensity and velocity of the pandemics are remarkably increased at some border lines of the Federal Republic.

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

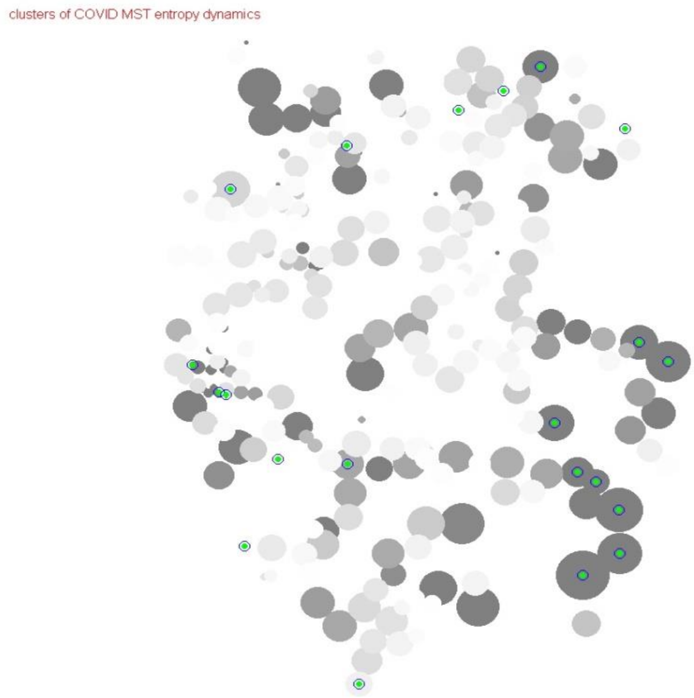

Figure 9: Map of German Public Health Centers and weekly difference of case number clusters (spatial movement of pandemic clusters during the observation period). Statistical significant changes are indicated by small green center circles.

The weekly changes of distant related incidences and death rates <Figure 7 and figure 8> as well as the computation of their hot spots <Figure 9 and figure 10> . display with the same figures. They cluster along the Eastern and North – Western boundary of the German Republic and leave the Southern (Alpine region) quite empty.

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

Figure 10: Map of German Public Health Centers and weekly difference of death number clusters (spatial movement of pandemic clusters during the observation period). Statistical significant changes are indicated by small green center circles.

Discussion: The COVID pandemics might be considered a human hazard that affects all countries worldwide (14). It is mainly a hazardous effect of human overpopulation in combination with intensive communication and transportation (14). Therefore, it is not accidentally that the first breakout was reported from the dense populated megacity Wuhan / West China in direct neighborhood with tropical forests and continuous railway connection to Europe (Western Industrial Region of Germany) (14).
Research to understand, investigate and develop effective protection against the pandemic focuses on anti- virus agents including conventional antibodies and mRNA macromolecules (30-33).
In addition, face masks and restrictive communication rules served for protection of the societies against airborne transmission and distance related infection modes (34-36).
All these efforts could successfully protect individual citizens of the societies and save numerous lives. However, a non-negligible percentage of citizens did not understand or want to understand the live-threatening virus pandemics and, consecutively, did resist against the strict administrative regulations [(37-42).

Maurice Weber, Norbert Rottmann, Fang Wei-Kleiner, Stephan Borkenfeld, Klaus Kayser Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

We want to demonstrate the general principles of COVID pandemics in regards of destroy and constant threat of human societies.
Our investigation period of the officially reported cases, incidence and death data covers 61 weeks, starting February 28, 2020 until March 15, 2021. During this period, 2,444,615 citizens were infected and 70,104 persons did not survive. The data were collected in 390 different public health centers which work under quite different individually organized and under the head of independent state administrations. No general standards and no digital communication did exist due to the very strict data protection law in Germany.
Therefore, the first challenge of this study was to detect potential inconsistencies and doubtful data, and to transfer potentially deficient excel files in SQL and MCV files.
These data files underwent statistical computation by both Python and DIAS – based self - written programs. DIAS program package has been developed by K. Voß at the University of Jena. DIAS is a powerful tool of several program components which cover image presentation, object segmentation as well as advanced algorithms of descriptive and analytical statistics (1).
<Figure 1> illustrates the registered cases and deaths. It took 4 weeks until the first 10 cases were documented, and additional five weeks until 11 deaths occurred. The first maximum of cases occurred at week 13 (36,617 cases) followed by a second peak at week 50 (173,517 cases). The associated graph of the registered deaths reveals maximum at week 13 (2,241 deaths) and at week 50 (6,091 deaths) too.
The congruent trend of both graphs indicates the weakness of the German public documentation system: the obviously expected difference between onset of the pandemic and associated deaths requires individual case follow up and not anonymous registration in completely separated public health centers (43-47). Otherwise fast and significant associations might not be detectable (43-47).
The associated graphs of (MST) entropy present with slightly different features (<Figure 2>). The entropy values remarkably increase at week 10 in both graphs (cases and deaths) and remain quite constant at that high level until they reach a second higher peak at week 50. Taking into account the meaning of MST entropy, both graphs indicate continuous 'nearly stable' characteristics of the system between week 10 and week 50. Thus, the forced or inborn changes of the system's characteristics remained unchanged and appeared to be constant.
The characteristics of the health centers' environment (offices in big cities or rural areas) do not indicate that they might modify the characteristics of the COVID pandemic. The relationship of documented cases and deaths between the five cohorts remained constant during the study's period (<Figure 3 and figure 4>).
Thus, the basic registration method does not depend on the different local conditions' and the reported data are not biased by individual public health center characteristics.
The geographic position of the health centers, however, displays with striking differences (<Figure 5 and figure 6>). Both reported cases and associated dead persons are more frequently reported from the eastern, northern and western borders of the German Federal Republic in contrast to the southern parts which are less affected. In addition, the pandemic

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

seems to be less intensive in 'inner' or central areas of the country when compared to the mentioned boundary districts.
This fact raises the question whether the 'open border strategy' of the federal government might explain the result. Germany joins these boundary areas with Denmark, Poland, The Netherlands, Belgium and France in combination in combination with dense labor, trade exchange and transportation. Different explanations such as lower population density inside of Germany are less likely. For example the missing impact of the health centers' type on incidence and death data (<Figure 3 and figure 4>).
The observed differences of the reported cases and death between neighboring weeks are depicted in <Figure 7 and figure 8>. Again, the most significant dynamics of (incidence / case numbers) are noted at the western and eastern borders as well as at the east - southern border of Germany (Czech Republic).The intensity of these dynamics seems to be shifted to the southern and the mortality changes to the northern districts.
What is the reason?
The answer might be given in <Figure 9 and figure 10>. These figures exemplarily depict the computed dynamic entropy clusters, indicated by 'greenish circles' within the involved greyish health centers. The measured MST entropy changes dominate the south – eastern and mid - west part of Germany and are close to the corresponding border. One might speculate that the new COVID virus variant (**Delta (B.1.617.2)** might be one agent that causes the significant entropy dynamics.

Conclusions: This study covers a period of one year (February 28, 2020 – March 15, 2021) and describes the pandemics in terms of reported cases, deaths, and derived Shannon and MST entropy calculations. The results indicate that COVID pandemics can be monitored by mortality and morbidity data. Both develop closely associated in the Federal Republic of Germany.
The reported data do not depend upon the type of any individual public health centers.
The observed gap between infected and dead persons amount to 4 – 9 weeks.
The dynamics of MST entropy and associated morbidity / mortality data aggregate along the Eastern, Western and mid – west districts of the German border.
Entropy calculations are a useful tool to describe additional features of COVID – pandemic associated features in the Federal republic of Germany.

References:

1. Klaus Voss HS. Praktische Bildverarbeitung. München, Wien: Carl Hanser Verlag; 1991.
2. Kiros M, Andualem H, Kiros T, Hailemichael W, Getu S, Geteneh A, et al. COVID-19 pandemic: current knowledge about the role of pets and other animals in disease transmission. Virol J. 2020;17(1):143
3. Klingelhofer D, Braun M, Bruggmann D, Groneberg DA. Coronavirus: An insight into global research until outbreak of COVID-19 and its implications for the future. J Glob Health. 2020;10(2):020508.

ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

4. Oldfield E, Malwal SR. COVID-19 and Other Pandemics: How Might They Be Prevented? ACS Infect Dis. 2020;6(7):1563-6.
5. Oral HIV self-test kit distribution cost effective in South Africa? PharmacoEcon Outcomes News. 2021;887(1):19.
6. CME Test. J Med Ultrasound. 2021;29(2):150.
7. Aalto-Korte K, Pesonen M. Patterns of positive patch test reactions to formaldehyde and formaldehyde releasers at the Finnish Institute of Occupational Health from 2007 to 2020. Contact Dermatitis. 2021;85(4):429-34.
8. Abou-Hanna JJ, Andrews CA, Khan NW, Musch DC, Jayasundera KT. Calculation of test-retest variability in phase I/IIa clinical trials for Inherited Retinal Degenerations. Ophthalmic Genet. 2021;42(3):283-90.
9. Rengeling D. [The 2020 Corona Pandemic-Beyond Omnipresent Prevention]. NTM. 2020;28(2):211-7.
10. Stang A, Standl F, Kowall B, Brune B, Bottcher J, Brinkmann M, et al. Excess mortality due to COVID-19 in Germany. J Infect. 2020;81(5):797-801
11. Ahmed I, Ahmad M, Rodrigues J, Jeon G, Din S. A deep learning-based social distance monitoring framework for COVID-19. Sustain Cities Soc. 2020:102571.
12. Assadiasl S, Fatahi Y, Zavvar M, Nicknam MH. COVID-19: Significance of antibodies. Hum Antibodies. 2020.
13. Calanchini J, Meissner F, Klauer KC. The role of recoding in implicit social cognition: Investigating the scope and interpretation of the ReAL model for the implicit association test. PLoS One. 2021;16(4):e0250068.
14. Kayser K, Rottmann N. From COVID-19 Infection to social level disease (SLD). Diagnostic Pathology. 2020;6(1)
15. Liu Q, Wu J, Zhang L, Sun X, Guan Q, Yao Z. The Relationship Between Perceived Control and Hypothalamic-Pituitary-Adrenal Axis Reactivity to the Trier Social Stress Test in Healthy Young Adults. Front Psychol. 2021;12:683914.
16. Liu Y, Pan H, Yang R, Wang X, Rao J, Zhang X, et al. The relationship between test anxiety and emotion regulation: the mediating effect of psychological resilience. Ann Gen Psychiatry. 2021;20(1):40.
17. Knebel MTG, da Costa BGG, Dos Santos PC, de Sousa A, Silva KS. The conception, content validation, and test-retest reliability of the Questionnaire for Screen Time of Adolescents (QueST). J Pediatr (Rio J). 2021.
18. Krumkamp R, Kreuels B, Jaeger VK, May J, Mikolajczyk R, Karch A. Negative SARS-CoV-2 PCR or rapid antigen test result and the subsequent risk of being infectious: a mathematical simulation study. BMC Med Res Methodol. 2021;21(1):165.
19. Lathyris D, Haidich AB. Meta-analysis of diagnostic test accuracy: Just another meta-analysis? Intensive Crit Care Nurs. 2021;64:103028.
20. Görtler J, Kayser K, Borkenfeld S, Carvalho R, Kayser G. Cognitive Algorithms and digitized Tissue – based Diagnosis. Diagnostic Pathology. 2017;3(1)

21. Kayser G, Görtler J, Weis CA, Borkenfeld S, Kayser K. The application of structural entropy in tissue based diagnosis. Diagnostic Pathology. 2017;3(1)

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

22. Kayser K. Das virtuelle Universum - Fiktion oder Realität. Berlin: Lehmanns media; 2020.
23. Kayser K, Gabius HJ. Graph theory and the entropy concept in histochemistry. Theoretical considerations, application in histopathology and the combination with receptor-specific approaches. Prog Histochem Cytochem. 1997;32(2):1-106.
24. Kayser K, Gabius HJ. The application of thermodynamic principles to histochemical and morphometric tissue research: principles and practical outline with focus on the glycosciences. Cell Tissue Res. 1999;296(3):443-55.
25. Kayser K, Gortler J, Bogovac M, Bogovac A, Goldmann T, Vollmer E, et al. AI (artificial i ntelligence) in histopathology--from image analysis to automated diagnosis. Folia histochemica et cytobiologica / Polish Academy of Sciences, Polish Histochemical and Cytochemical Society. 2009;47(3):355-61.
26. Kayser K, Hoshang SA, Metze K, Goldmann T, Vollmer E, Radziszowski D, et al. Texture- and object-related automated information analysis in histological still images of various organs. Anal Quant Cytol Histol. 2008;30(6):323-35.
27. Kayser K, Berthold S, Eichhorn S, Kayser C, Ziehms S, Gabius HJ. Application of attributed graphs in diagnostic pathology. Anal Quant Cytol Histol. 1996;18(4):286-92.
28. Kayser K, Bovin NV, Korchagina EY, Zeilinger C, Zeng FY, Gabius HJ. Correlation of expression of binding sites for synthetic blood group A-, B- and H-trisaccharides and for sarcolectin with survival of patients with bronchial carcinoma. Eur J Cancer. 1994;30A(5):653-7.
29. Kayser K, Fitzer M, Bulzebruck H, Bosslet K, Drings P. TNM stage, immunohistology, syntactic structure analysis and survival in patients with small cell anaplastic carcinoma of the lung. J Cancer Res Clin Oncol. 1987;113(5):473-80.
30. Chung H, He S, Nasreen S, Sundaram ME, Buchan SA, Wilson SE, et al. Effectiveness of BNT162b2 and mRNA-1273 covid-19 vaccines against symptomatic SARS-CoV-2 infection and severe covid-19 outcomes in Ontario, Canada: test negative design study. BMJ. 2021;374:n1943.
31. Cowan B, Klein E, Jansz K, Westenfelder K, Bradford T, Peterson C, et al. Longitudinal follow-up and performance validation of an mRNA-based urine test (Xpert((R)) Bladder Cancer Monitor) for surveillance in patients with non-muscle-invasive bladder cancer. BJU Int. 2021.
32. Jaganathan S, Stieber F, Rao SN, Nikolayevskyy V, Manissero D, Allen N, et al. Preliminary Evaluation of QuantiFERON SARS-CoV-2 and QIAreach Anti-SARS-CoV-2 Total Test in Recently Vaccinated Individuals. Infect Dis Ther. 2021.
33. Safarika A, Wacker JW, Katsaros K, Solomonidi N, Giannikopoulos G, Kotsaki A, et al. A 29-mRNA host response test from blood accurately distinguishes bacterial and viral infections among emergency department patients. Intensive Care Med Exp. 2021;9(1):31.
34. Birkett ST, Harwood AE, Caldow E, Ibeggazene S, Ingle L, Pymer S. A systematic review of exercise testing in patients with intermittent claudication: A focus on test

Medical Journal of Virtual Science 2021 1:4
ISSN 2747-8920

DOI: http://dx.doi.org/10.17629/www.medical-journal-of-virtual-science.de-2021-1:4

standardisation and reporting quality in randomised controlled trials of exercise interventions. PLoS One. 2021;16(5):e0249277.

35. Braghieri HA, Kanegusuku H, Corso SD, Cucato GG, Monteiro F, Wolosker N, et al. Validity and reliability of 2-min step test in patients with symptomatic peripheral artery disease. J Vasc Nurs. 2021;39(2):33-8.
36. Pathak KP, Gaire T, Ho MH, Chang HCR. Why has COVID-19 not hit the countries like ^ Nepal yet? Rev Environ Health. 2020.
37. Ala A, Wilder J, Jonassaint NL, Coffin CS, Brady C, Reynolds A, et al. COVID-19 and the Uncovering of Health Care Disparities in the United States, United Kingdom and Canada: Call to Action. Hepatol Commun. 2021.
38. Capasso M, Caso D, Conner M. Anticipating pride or regret? Effects of anticipated affect focused persuasive messages on intention to get vaccinated against COVID-19. Soc Sci Med. 2021;289:114416
39. Esterhuizen W, Levine J, Streif S. Epidemic management with admissible and robust i nvariant sets. PLoS One. 2021;16(9):e0257598.
40. Holness NA, Powell-Young YM, Torres E, DuBois S, Giger JN. Covid-19, Pregnancy, and Vaccinations. J Natl Black Nurses Assoc. 2021;32(1):1-9.
41. Suliman DM, Nawaz FA, Mohanan P, Modber M, Musa MK, Musa MB, et al. UAE efforts in promoting COVID-19 vaccination and building vaccine confidence. Vaccine. 2021.
42. Thakore N, Khazanchi R, Orav EJ, Ganguli I. Association of Social Vulnerability, COVID-19 vaccine site density, and vaccination rates in the United States. Healthc (Amst). 2021;9(4):100583.
43. Kayser K, Burkhardt HU. The Regional Cancer Registry in North Baden: a review of four years' experience. Med Inform (Lond). 1981;6(2):99-108.
44. Kayser K, Burkhardt HU. Population based pathology statistics of oesophageal carcinoma. J Cancer Res Clin Oncol. 1983;105(3):292-8.
45. Kayser K, Burkhardt HU, Jacob W. The regional registry of gastro-intestinal cancer North Baden (2.2 million inhabitants). Virchows Arch A Pathol Anat Histol. 1978;380(2):155-62
46. Kayser K, Burkhardt HU, Jacob W. [The patho-anatomical Regional Cancer Registry of North Baden]. Fortschr Med. 1978;96(37):1831-5.
47. Kayser K, Kayser G. Virtual Predictive Autopsy: From knowledge and understanding to education, research and communication in digital tissue – based diagnosis. Diagnostic Pathology. 2019;5(1).