Clinical Infectious Diseases

BRIEF REPORT

Evaluation of the United States definitions for COVID-19 community risk levels

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The United States CDC defines a county metric of COVID-19 Community Levels to inform public health measures. We find that the COVID-19 Community Levels vary frequently over time, which may not be optimal for decision making. Alternative metric formulations that do not compromise predictive ability are shown to reduce variability.

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INTRODUCTION

In the United States during the COVID-19 pandemic, county-specific risk of SARS-CoV-2 infection has been estimated using COVID-19 case, hospitalization, and death data. These risk estimates ultimately help both individuals and communities in decision-making around infection prevention strategies [1-3]. On March 4, 2022, the United States Centers for Disease Control and Prevention (CDC) developed COVID-19 Community Levels to better estimate county level risk [1,4]. The community metrics are intended to inform control strategies based on explicit goals of reducing the risk of severe illness and healthcare strain [1,4]. The CDC characterized COVID-19 community levels as low, medium, or high on the basis of new COVID-19 cases, hospital admissions and inpatient bed use. Community levels may trigger different intervention strategies including testing, case isolation, masking, and vaccination. A CDC Science Brief describing the design of these metrics reported that definitions of community levels were chosen to maximize predictive accuracy for disease burden over a three-week window [4]. Moreover, a recent study has shown that the CDC metrics had moderate (~70) positive predictive value of elevated COVID-19 mortality at county-level in the U.S. during the Delta and Omicron variant transmission periods [5].

Optimal public health recommendations for disease control should vary with disease risk and burden [6]. However, frequent changes in public health recommendations may increase operational and logistical efforts and reduce public adherence to government guidelines [7]. In this study we evaluated the temporal variation of the CDC COVID-19 community level, and compared it to alternative community level metrics.

METHODS

Data sources

We used publicly available data to generate the county-level CDC COVID-19 community levels [1, 4]. Data on COVID-19 occupied inpatient beds and hospital admissions data were obtained from the U.S. Department of Health & Human Services [8]. The beds occupancy data were provided at the hospital level, and suppression was applied to entries of less than four occupied beds (See Supplement Material for details). COVID-19 case data were obtained from the CDC county level dataset [9].

Statistical analysis

We assigned CDC COVID-19 community levels to each county as per the CDC guidelines [1]. Consistency in community level was assessed at the county level over the two-year period. This is a weekly binary outcome based on whether a given county remained at the same community level over a consecutive number of weeks. We generated an overall consistency rate as the mean of all counties over time. We evaluated the temporal variation in the categorization of county risk levels, and the rate of change of risk level under the CDC community risk level metrics. For each county, the rate of change was defined as the ratio of total number of weeks that the risk level change compared to the previous week over the total number of weeks between July 31, 2020 and July 31, 2022. We evaluated the relationship between rate of change of COVID-19 community risk level and county population size, urbanization level, and number of hospitals. We used county population data from the 2020 American Community Survey (ACS) and urbanization level from the 2013 Urban-rural classification from the National Center for Health Statistics (NCHS) (Fig. S1, see Supplement Material for details).

For comparison to the CDC metrics, we consider an alternative metric (Alternative 1) that has been shown to have similar predictive ability to the CDC metrics (see Supplemental Materials for full definition) [5]. Alternative 1 lowers the COVID-19 inpatient staffed bed occupancy threshold from 10% to 5% (7-day average).

RESULTS

Under the current CDC metrics, we show that between July 31, 2020 and July 31, 2022, approximately 25% of US counties changed their risk level from one week to the next and 40% changed their risk level at least once over a three weeks period (Figure S2A). During the same time period, 75% of counties had a weekly rate of change greater than 20% (Figure S2B & C). The three-week consistency rate was 62.9% [Interquartile range (IQR): 49.7–72.4%] for low community level counties, 30.0% [IQR: 25.1–33.1%] for medium community level, and 57.2% [IQR: 43.3–79.9%] for high community level counties (Figure 1).

We found that population size and number of hospitals were negatively associated with the rate of change in risk level (Figure S3), whereas rural population percentage and density of hospitals were positively associated with the rate of change in risk level (Figure S3). Using the NCHS Urban-Rural classification, we found that the rate of change was significantly different between metropolitan and non-metropolitan counties (Figure S4) and that for each community risk level, consistency rate decreases with decreasing county urbanization level and population size (Figure S5). For each NCHS category, medium risk counties had the lowest consistency rate (Figure S5). This consistency rate was 30% or lower in small metropolitan, micropolitan, and noncore counties (Figure S5).

Approximately 40% of the hospital data on COVID-19 bed occupancy data were suppressed. By excluding suppressed data, we obtained lower frequency of variation of community risk level and higher consistency rates of all community levels (Figures S6 & S7). For example, the three-week consistency rate was 83.7% [IQR: 64.4– 91.4%] for low, 35.3% [IQR: 26.6– 43.3%] for medium, and 81.7% [IQR: 66.4– 94.7%] for high risk counties (Table S2). Though excluding suppressed data improved the consistency rate of high and low community risk level counties, the frequency of change of medium community risk level counties remain low (Figures S6 & S7).

We evaluated an alternative metric for COVID-19 community level. When simulating (or excluding) suppressed hospitalization data, the three-week consistency rate for medium risk counties was 45.4% [IQR: 37.4–49.5%] (45.3% [33.7–54.9%]) under Alternative 1 metrics, compare to 30.0% [IQR: 25.1–33.1%] (35.3% [26.6– 43.3%]) under the CDC metrics (Tables S1 & S2). Additionally, we found reducing lower threshold value of bed occupancy for low COVID-19 community level substantially improved the consistency rate of medium risk level counties with marginal impact on the consistency of low risk level counties (Figures 1 & S8, Tables S1 & S2).

In addition to Alternative 1, we also consider an Alternative 2 that lowers bed occupancy threshold to 5% and new hospital admission to 5 per 100,000 population, although its predictive ability was not evaluated by the CDC (Figure S9, Tables S1 & S2). Consistency rate for medium risk counties was 53.3% [IQR: 44.1–58.3%] (55.0% [45.7–65.1%]) under Alternative 2.

DISCUSSION

This study found that current CDC COVID-19 community levels experience considerable variation in the categorization of county risk level. The degree of variation in risk level experienced by a given county depends on population and urbanization. Large metropolitan counties have experienced significantly less variation in their community level than their smaller counterparts, which in turn have experienced less variation than rural counties.

Alterative formulations of the CDC COVID-19 community levels may improve stability for medium risk level and would increase the number of countries in this grouping. We anticipate that these alternative metrics would have similar predictive performance of elevated mortality risk to current CDC metrics because of their similar definitions of high community levels [5]. However, prospective validation of their consistency and predictive value would be key to confirm their public health utility. Changing the COVID-19 community level metrics may not be without unintended consequences, though anticipated to be minimal. Though public health recommendations should avoid disproportionate restrictions relative to risk, the targeted nature of the CDC community level recommendations to high risk individuals and settings would likely minimize the impact of undue restrictions and underestimating the underlying COVID-19 community risk level. Our analysis shows a lower consistency rate in rural and low population counties (Figures S7-S9) which suggests that it may be reasonable to consider different threshold values for these types of jurisdictions.

Our study has several limitations. We do not assess whether the CDC threshold level values or associated prevention measure recommendations are optimal for mitigating the risk and burden of COVID-19. Although consistency rate, as defined here, is a good measure of temporal variation of county-specific COVID-19 community level, other outcome measures could be used for the same purpose. However, we anticipate minimal impact on the qualitative nature of our results. The CDC also provides transmission level metrics to describe the amount of COVID-19 spread in each county, which is subject to bias due to at-home rapid antigen tests not being included in surveillance reports [10,11]. In contrast, the CDC community levels, which rely on severe outcomes, are not expected to be biased by at-home test reporting. Further study could evaluate the consistency of the county transmission levels across counties as it compares to the COVID-19 community levels.

Although minimizing variation of public health recommendations should not be the primary objective in designing public health metrics for disease control, our study showed that current CDC metrics for COVID-19 community levels vary frequently, which may not be ideal for guiding public health decision making. Alternative formulations of these metrics may reduce variability without compromising predictive ability to inform policy. Future work should develop a systematic framework to optimally identify such threshold values and corresponding prevention strategies.

NOTES

Authors' Contributions: MNM designed the project and analysis; SM performed the analysis; SM and ASP drafted the manuscript; MNM, ASP, and NCL interpreted the results; MNM, ASP, and NCL performed final editing.

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Data sharing: No additional data available.

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FIGURE LEGEND

Figure 1: County-level consistency rate of CDC COVID-19 community levels and comparison to alternative 1 metrics over study period. Consistency rate for the CDC COVID-19 community level (see Supplement Materials for details) was computed over the study period from July 31, 2020 to July 31, 2022. The consistency rate was computed as the proportion of counties that remained at the same community level during a consecutive three weeks period given that they

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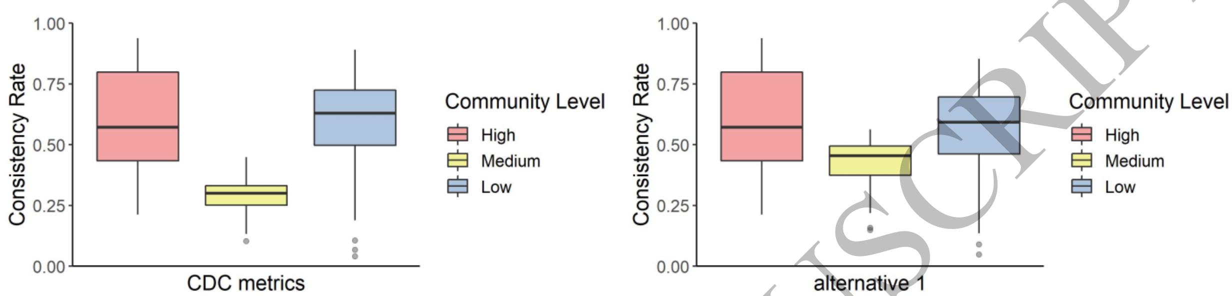
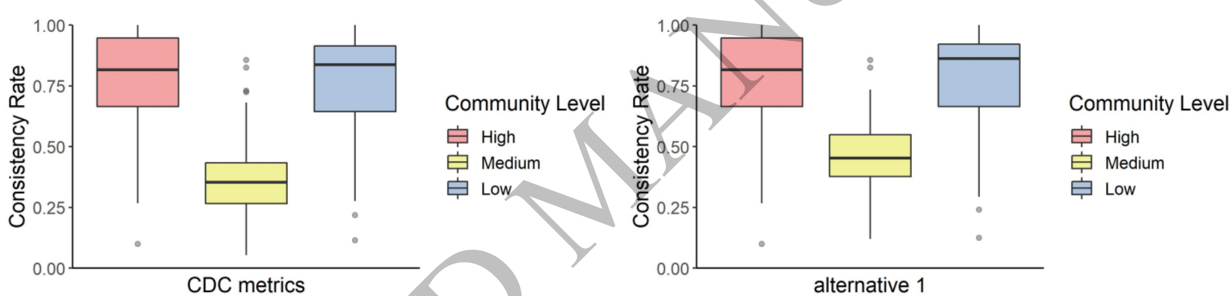
were at that community level during the first week of the three weeks. This analysis was completed for an alternative metric (alternative 1), where the COVID-19 inpatient staffed bed occupancy threshold is lower from 10% to 5%. Consistency rate was computed under two scenarios to account for suppressed data (due to low numbers), (A) by accounting for suppressed data, and (B) by excluding suppressed data.

A) Distributions of 3-week community risk level consistency rates



B) Distributions of 3-week community risk level consistency rates (without suppressed hospital data)



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