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Short communication

County-level association of diabetes and obesity with premature mortality

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ABSTRACT

Objective: The association between the prevalence of diabetes and obesity and premature mortality at the county-level has not been well characterized. This study aims to elucidate the relationship between county-level prevalence of diabetes and obesity and premature mortality.
Methods: We utilized the data from the 2022 County Health Rankings which obtained the data from Behavioral Risk Factor Surveillance System in 2019, and National Center for Health Statistics Mortality Files 2018–2020. The county prevalence of diabetes and obesity was determined, and univariable and multivariable associations with premature mortality were identified.
Results: Among 3082 counties, the percentage of individuals with diabetes ranged from 5.5 to 21.0 % and the percentage of individuals with obesity ranged from 16.4 to 51.0 %. Our analysis revealed a stepwise increase in premature age-adjusted death rates (AADR) with rising deciles of county-level diabetes ($P < 0.001$) and obesity ($P < 0.001$) in both univariable and multivariable models.
Conclusions: These findings underscore the significance of addressing diabetes and obesity at the county-level to reduce premature mortality and improve population health outcomes across varied communities in the United States.

1. Introduction

A robust association exists between diabetes and obesity, underscored by numerous studies describing the heightened mortality risks associated with each condition (Chen et al., 2019). Both diabetes and obesity also define stages of multimorbidity within the newly described cardiovascular-kidney-metabolic syndrome (Minhas et al., 2024a). In 2021, diabetes affected nearly 15 % of the United States (US) adult population and its prevalence is expected to triple by the year 2060 (National Institute of Diabetes and Digestive and Kidney Diseases, 2024; Lin et al., 2018). Concurrently, obesity affects approximately 40 % of the population and prevalence continues to rise nationwide with large geographic disparities in the US (Centers for Disease Control and Prevention, 2024; Ward et al., 2019). Identifying locales and regions experiencing disproportionate impacts of diabetes and obesity due to their socioeconomic environment or other factors is critical to mitigating the health risks associated with these conditions; with a focus on county-level data potentially being more actionable than evaluation of state or nation-wide associations (Wallace et al., 2019). Therefore, we sought to evaluate the association of diabetes and obesity with premature mortality at the county-level in the US.

Abbreviations: AADR, age-adjusted death rate.

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2. Methods

The county-level data for this analysis was included from the 2022 County Health Rankings data set (The University of Wisconsin Population Health Institute, 2025). Institutional review board approval was not sought because of publicly available data. Informed consent was not required because of publicly available deidentified data. The data used in this analysis are publicly available and cover a total of 3142 counties. County-level obesity represents the percentage of the adult population (age 18 years and older) that reports a body mass index greater than or

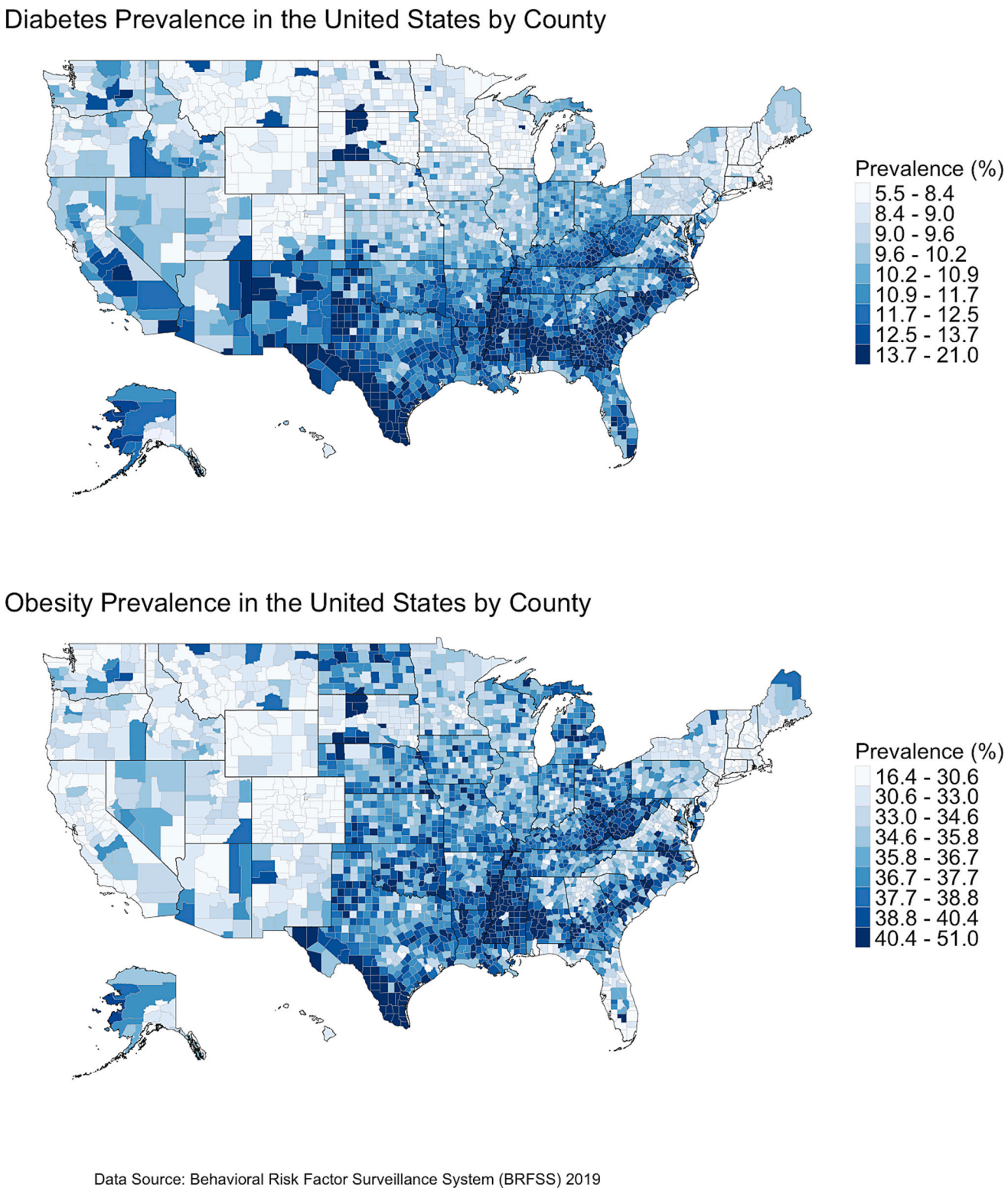

Fig. 1. Heat maps of adult diabetes (≥ 20 years) and obesity (≥ 18 years and ≥ body mass index of 30 kg/m^2) prevalence in the United Stated by county (age-adjusted).
Data are from the 2022 County Health Rankings, presented for all 3142 counties without missing data.

equal to 30 kg/m^2 (age-adjusted), obtained from Behavioral Risk Factor Surveillance System (BRFSS) 2019. County-level diabetes represents the percentage of adults aged 20 and above with diagnosed diabetes (age-adjusted), obtained from BRFSS 2019. Premature mortality denotes the number of deaths among residents under age 75 per 100,000 population (age-adjusted), obtained from National Center for Health Statistics - Mortality Files 2018–2020. Counties with missing information on premature mortality were excluded from the analysis ($N = 60$). Counties were divided into 10 deciles based on the prevalence of diabetes and obesity. Univariable and multivariable linear regression were used to evaluate the association of premature AADR with obesity and diabetes (lowest deciles as reference). β-coefficients were computed, representing the increase in premature AADR relative to the reference decile. The multivariable model included both diabetes and obesity as covariates. Additionally, diabetes and obesity prevalence were evaluated as continuous variables. To test if the relationships of premature AADR with diabetes and obesity were nonlinear, we added quadratic terms of diabetes and obesity (evaluated in separate models for each); the changes in model fit were tested using the likelihood ratio test. Given the nonlinear response, we proceeded to utilize two-piecewise linear regression. Lastly, we also evaluated the relationship between county-level diabetes and obesity using the two-piecewise linear regression (given the nonlinearity) with diabetes as a dependent variable. All analyses were conducted using Stata 18.0 (Stata Corp. 2023, College Station, TX).

3. Results

In our analysis, 3082 counties with available data on the prevalence of diabetes, obesity, and premature AADR, were included. The percentage of individuals with diabetes between counties ranged from 5.5 to 21.0 %, and the mean percentage of individuals with diabetes from the 1st to 10th decile ranged from 7.6 % (standard deviation ±0.5 %) to 15.6 ± 1.6 % (Fig. 1). Similarly, the percentage of individuals with obesity between counties ranged from 16.4 to 51 %, with the mean percentage of individuals with obesity from the 1st to 10th decile ranging from 27.4 ± 2.4 % to 42.9 ± 2.2 % (Fig. 1). Results for piecewise linear regression between county-level diabetes and obesity were as

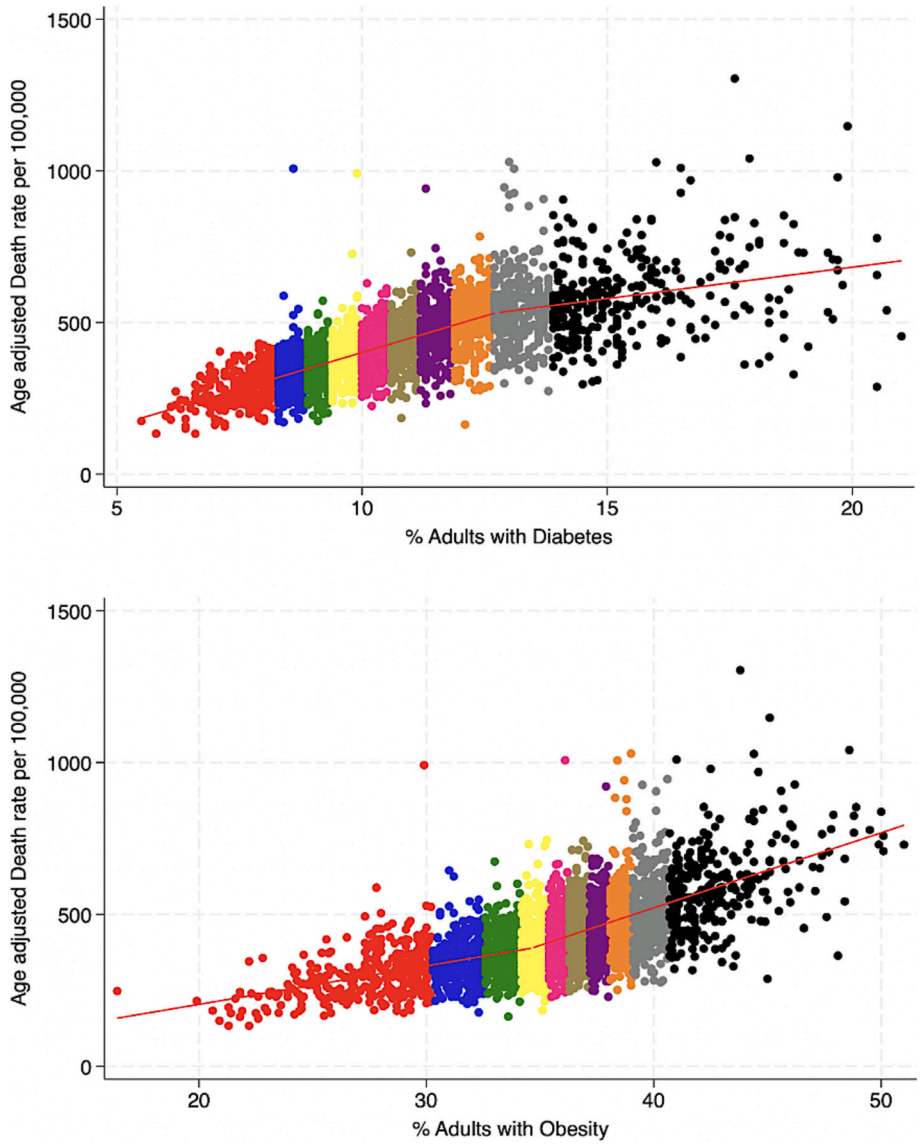

Fig. 2. County-level premature age-adjusted death rate per 100,000 (age < 75 years) by decile of diabetes and obesity prevalence in 3082 counties in the United States.
Data are from the 2022 County Health Rankings. Each decile is represented by a different color, with red lines representing piecewise linear regression lines. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

follows: β-coefficient$_{left}$ 0.20, CI 0.18–0.23, $P < 0.001$, β-coefficient$_{breakpoint}$ 35.83, CI 35.42–36.23, $P < 0.001$, β-coefficient$_{right}$ 0.64, CI 0.61–0.67, $P < 0.001$ (Supplemental Fig. 1).

There was a stepwise increase in premature AADR across deciles of county-level diabetes and obesity as shown in Fig. 2, Supplemental Table 1. Both diabetes and obesity remained independently associated with premature mortality in the multivariate model (Supplemental Table 1). Results for piecewise linear regression model were as follows: diabetes (breakpoint 12.7 %, CI 12.2–13.2 %, $P < 0.001$, β-coefficient$_{left}$ 48.1, CI$_{left}$ 45.8–50.4, $P < 0.001$ and β-coefficient$_{right}$, 20.7 CI$_{right}$ 16.5–24.8, $P < 0.001$) and obesity (breakpoint 34.6 %, CI 33.7–35.6 %, $P < 0.001$, β-coefficient$_{left}$ 12.6, CI$_{left}$ 10.7–14.6, $P < 0.001$ and β-coefficient$_{right}$ 24.7, CI$_{right}$ 23.1–26.4; $P < 0.001$), Fig. 2.

4. Discussion

In this analysis, we note that both diabetes and obesity prevalence at the county-level demonstrate stepwise associations with premature mortality. Additionally, we demonstrate that counties in the US have approximately a fourfold difference in the prevalence of diabetes and threefold difference in the prevalence of obesity between the lowest and highest counties, which shows substantial variation in health-related disparities across US counties. Understanding the relationship of county-specific healthcare requirements could inform targeted resource allocation strategies and enhance the efficacy of public health interventions.

Previous studies have demonstrated the elevated risk of cardiovascular events associated with cardiovascular risk factors including diabetes and obesity (Gebreab et al., 2015), however, there is limited information on the county-level prevalence of diabetes and obesity and the relationship between their prevalence and premature mortality (Cunningham et al., 2018; Shrestha et al., 2012). Our results demonstrate significant variation in the prevalence of diabetes and obesity across US counties and an association between the prevalence of these conditions and premature mortality.

These results have implications for public health efforts to optimize cardiovascular disease risk factors with the goal of reducing premature mortality. Both diabetes and obesity have received greater public health focus aimed at identifying and reducing the effects of these related comorbidities, including their incorporation into the newly described cardiovascular-kidney-metabolic syndrome. Therefore, awareness of the regional variability of these risk factors may be important to address the burden of diabetes and obesity. County-level variability is particularly important because socioeconomic and environmental factors have been identified as important contributors to the incidence of diabetes and obesity, with studies noting a direct relationship between the two diseases at the county-level (Cunningham et al., 2018). The significance of where a person lives may be greater than a mere association between residence location and obesity or diabetes, as evidenced by a large-scale social experiment where individuals randomized to an opportunity relocate to a lower poverty region were noted to have a reduction in the prevalence of diabetes and obesity compared to a control group (Ludwig et al., 2011). Therefore, additional public health focus on counties with a higher prevalence of diabetes and obesity may facilitate efforts to target both individual and community-wide risk factors, including socioeconomic factors, which are associated with these conditions. For example, rural regions, and counties with socioeconomic inequalities may offer lower access or other barriers to specialty care (Minhas et al., 2024b; Minhas et al., 2023), with telehealth services potentially able to bridge that gap (McDonnell, 2018). Likewise, utilizing low-cost technological innovations has been proposed to integrate healthcare providers with patient needs at the community level as a way to narrow existing socioeconomic disparities between communities (Tung and Peek, 2015).

Furthermore, targeting public health efforts towards small regions such as counties may be complementary with public health efforts that target individual patients or that target broader regions (such as state-based or country-wide efforts). Systematic reviews have highlighted successful city- and community-based interventions that reduced obesity through multi-level, multi-component approaches (Danielli et al., 2021; Tseng et al., 2018). For example, large cities have been successful at implementing programs to improve walkability and to alter nutrition with regional programs (Green and Klein, 2011; Ma et al., 2016). The ability of these programs applied at targeted geographic regions, which approximate counties, underscore the value of local public health initiatives in driving sustainable health improvements.

Our study has limitations. Given the observational, retrospective nature of the study, causality cannot be established. Disparities based on socioeconomic status, education level, race, ethnicity, and rural versus urban residence may influence lifestyle choices and outcomes, factors not directly addressed in our analyses. Multivariable analysis was not adjusted for other known risk factors, such as hypertension and coronary artery disease. Etiology of nonlinear association of diabetes and obesity with premature AADR (and diabetes and obesity) is unclear but could be related to county-level differences in other environmental, socioeconomic, or health factors which are not evaluated in our analysis. Future studies should address county-level factors that predispose to conditions including diabetes and obesity.

5. Conclusion

The prevalence of diabetes and obesity varies widely across US counties, with both conditions showing stepwise associations with premature mortality. These observations underscore the significance of addressing regional disparities in risk factors to mitigate regional disparities in health outcomes. Identifying modifiable factors, including targeted healthcare policies and programs, warrants investigation to bridge the gap in county-level health disparities.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2025.103042.

CRediT authorship contribution statement

George W. Hafzalla: Writing – review & editing, Writing – original draft, Visualization. **Dmitry Abramov:** Writing – review & editing, Supervision, Resources. **Ahmed Sayed:** Writing – review & editing. **Jamal S. Rana:** Writing – review & editing. **Anurag Mehta:** Writing – review & editing. **Giv Heidari-Bateni:** Writing – review & editing. **Abdul Mannan Khan Minhas:** Writing – review & editing, Resources, Methodology, Investigation, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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