The Impact of Rurality on the Associations between Informal Caregiving and Health in the United States: A County-Level Assessment

Brief Abstract

Over 50 million caregivers provide informal care to individuals living with disabilities and chronic illness, benefitting society by reducing costs and strains on the healthcare system. Associations between caregiving and negative health outcomes are well-documented. Few studies to date have examined if and how rurality alters these associations. The objective of this study was to assess how the associations between caregiving and health are modified by rurality. We used 2009 Behavioral Risk Factor Surveillance System (BRFSS) county-level data to assess potential effect modification by rurality using stratification and interaction terms. Our findings suggest that the negative associations between caregiving and three health outcomes, self-reported health, exercise, and mental health status, depend strongly upon county rurality, although the direction of the effect modification were inconsistent. Caregivers in rural communities experience more health-related consequences, possibly due to issues surrounding social support or infrastructure needed to mitigate these health effects of caregiving.

Extended Abstract

"Health care" is commonly thought to be exclusively provided by health professionals, such as physicians and nurses. Yet, in the US, there are over 50 million caregivers who provide informal care to individuals living with disabilities and chronic illness, comprising a critical part of healthcare delivery. The provision of informal care is essential both to the care recipients and to society because it reduces costs and strains on the healthcare system. Although there are positive health benefits of caregiving for the caregiver, the associations between caregiving and several negative health outcomes are well-documented. Few studies to date have examined how these associations differ by location and rurality, however. Therefore, the objective of this study was to assess how the association between caregiving and health status and specific health outcomes are modified by rurality. We used 2009 Behavioral Risk Factor Surveillance System (BRFSS) data to assess the potential for effect modification by rurality using stratification and adjusting for interaction terms. Our findings suggest that the negative associations between caregiving and several health outcomes, including self-reported health, exercise, and mental health status, depend upon rural-urban status. Although the findings were mixed, there is evidence to suggest that caregivers in rural communities may experience more detrimental health-related consequences of informal caregiving, possibly due to issues surrounding social support or infrastructure needed to mitigate these health effects of caregiving. Additionally, these findings support the need to stimulate research and develop policies and programs designed to protect the health of rural informal caregivers, to maintain and strengthen this vital component of the health care system across the US.

Background

In the United States, over 50 million informal caregivers comprise an essential part of health care delivery, saving the national economy $200 billion per year that would otherwise be spent on institutional care and formal in-home caregiving (Arno, et al., 1999). The economic value of unpaid, informal caregiving to older adults actually surpasses national spending on formal care, such as home health care workers and institutional care (Harrow, et al., 2004). Informal caregiving has benefits beyond the substantial contribution to the US economy, both to the care recipients and to the caregivers themselves, including increased life satisfaction and personal fulfillment (Ekwall and Hallberg, 2007). Of the informal caregiver population, most caregivers provide care to adults age 50 and above, saving older adults from potentially costly and unnecessary institutionalization. The majority of informal caregiving in the US is provided by family members, many of whom are members of the "sandwich generation", those who provide care to older relatives and children (Grundy & Henretta, 2006; Rubin & White-Means, 2009). Nearly all informal caregivers (92%) are the spouses, children, or other relative of the beneficiary (Gibson & Houser, 2007; Spector, et al., 2000).

Health effects of caregiving are diverse, a recent French study suggested that caregivers with a low burden of caregiving duties had a lower incidence of depression than non-caregivers (Buyck, et al., 2011). Results of a longitudinal study suggested that institutionalization after caregiving does not actually reduce depression and anxiety after institutionalization, even though the "burden" on the caregiver had been lifted. For several outcomes, the incidence of certain negative health outcomes increases after institutionalization and informal caregiving ends (Schulz, et al., 2004). Despite the benefits of informal caregiving for the recipient, the caregiver, and the national economy, caregiving can be potentially detrimental to the health and wellbeing of the informal caregiver (Beach, et al., 2000; Brummett, et al., 2006; Schulz, et al., 1997). Even within the population of informal caregivers themselves, caregiving intensity and its effects on caregiver health vary substantially (Haley, et al., 2004; Navaie-Waliser, et al., 2002a). For example, caregivers who provide informal care to dementia patients spend significantly more time providing

care, and experience greater impacts with respect to employment, physical and emotional strain, leisure time, and overall physical and mental health, among other factors, than caregivers to non-dementia patients (Ory, et al., 1999). Informal caregivers spend substantial time and resources providing care, especially to those patients with the most severe functional and cognitive limitations (Covinsky, et al., 2003), rendering it a highly demanding activity for the caregiver. Each week, one-quarter of all informal caregivers to dementia patients spend over 40 hours providing this crucial care (Langa, 2001). Such intensive time investment impacts the physical (Kiecolt-Glaser et al., 2003) and mental health of caregivers (Cannuscio et al., 2002; MacNeil, et al., 2010; Shultz, et al.,1995), especially for those with little social support (Williams, et al., 2008). Preventive health behaviors in caregivers are also negatively impacted by caregiving (McGuire, et al., 2010). However, the importance of protecting the health of informal caregivers extends beyond the immediate benefits to the caregivers themselves. Protecting the health of caregivers strengthens this essential part of the health care system for the US as a whole, and enhances the health and wellbeing of the care recipients themselves through improved communication and a reduction of the risk of elder abuse (MacNeil, et al., 2010).

There is also distinct variation in the distribution and impacts of informal caregivers by demographic factors, such as gender (Navaie-Waliser, et al., 2002b) and rurality (Glasgow, 2000). For instance, rural caregivers experience isolation, often leading to worse health outcomes as a result of caregiving (Butler, 2005). One study found that rural caregivers had access to fewer formal support systems. While there was no significant association between caregiver burden and healthy behaviors in urban caregivers, there was a strong correlation between burden and healthy behaviors for rural caregivers (Bédard et al., 2004).

Compounding this issue is population aging. The US population aged 65 and above is expected to increase from over 34 million to 71 million by 2030, during which time the population aged 85 and above will grow from 6 million to 9 million. As the population continues to age, the need for informal caregiving will likely increase over the coming decades. Population dynamics will likely affect not only the demand for informal caregiving, but also the geographic distribution of

informal caregivers. As the Baby Boomer population ages into the older age categories at greater risk of developing cognitive limitations, the relative number of people in the next generation available to provide informal care will be lower compared to the current situation. Therefore, the need to find specific, modifiable pathways through which we can protect caregiver health is critical.

The CDC's Behavioral Risk Factor Surveillance System (BRFSS), the world's largest health survey of over 400,000 participants annually from all 50 states and the District of Columbia, included questions asked of all participants about informal caregiving. Using the BRFSS, we conducted a secondary data analysis as a first step in achieving the long-term goal of improving the health of informal caregivers. The objective of this study is to determine how the associations between informal caregiving and caregiver health, including self-reported health and preventive health behaviors such as nutrition, exercise, and immunizations, are modified by rurality. Our hypothesis is that the associations between informal caregiving and adverse health outcomes will be stronger in rural areas than in urban or intermediate areas.

Methods

Exposure Variable. To test the hypothesis described above, we utilized 2009 BRFSS data using the entire sample, consisting of 432,607 participants. The analysis was restricted to those who responded either "yes" or "no" to the question asked of all participants: "People may provide regular care or assistance to a friend or family member who has a health problem, long-term illness, or disability. During the past month, did you provide any such care or assistance to a friend or family member?" This question also served as the primary outcome variable to compare informal caregivers to non-caregivers

Outcome Variables. Three outcome variables of health effects were examined. These outcome variables include self-reported health status (1: excellent, 2: very good, 3: good, 4: fair, 5: poor), number of days in the past 30 days of poor mental health, and exercise (yes/no).

Mediator and Moderator Variables. In this analysis, we controlled for potential confounding by considering the following independent variables in the regression models: age, sex, number of

children, income, employment status, and education level. Since the objective of the study was to determine if and how associations between caregiving and the aforementioned measures of health are modified by rurality and socioeconomic status, we assessed potential effect modification through the inclusion of moderator variables on the county level. County-level rurality was derived from the 2010 US Census Bureau Decennial Census, with county matching between datasets based on FIPS codes. Rurality was quantified based on the calculation of population density, which was conducted by dividing the population of each county by its land area. Counties were ranked from low to high population density, and divided into tertiles based on population density, a method adapted from studies of rurality (Cordes, 1985). This population density tertile variable was used as the primary measure of rurality and was linked to each case in the BRFSS data set.

Statistical Analysis. Univariate statistics were assessed for all variables; distributions were visualized using histograms and boxplots. Frequencies were tabulated for all categorical and ordinal variables using tables and bar charts, where appropriate. Bivariate analyses were conducted between the outcome and predictor variables, and among all predictor variables using Pearson's and Spearman's correlations, t-tests, Wilcoxon Rank Sum tests, chi square tests, Fisher's exact tests, and other tests, once the distribution of each variable was known.

To test the central hypotheses, we used generalized linear regression models (GLM) to assess the associations between caregiving and each of the outcome variables. GLM provides the flexibility to use outcome variables whose distributions deviate from normality, including Poisson and binomial processes. Variables were designated "confounders" if the addition of the variable in the regression model changes the associated parameter estimate for the main effect of caregiving at least 10% in either direction. Effect modification by rurality was evaluated in two ways: through stratifying the sample by socioeconomic status, and by the use of interaction terms to quantify the potential interaction. GLM also allows for the simultaneous modeling of both random and fixed effects, and for potentially non-independent covariance in the data. SAS version 9.2 (Cary, NC) was used for all statistical analyses. The details for each hypothesis are outlined here:

Hypothesis 1: Caregivers will have poorer self-reported health than demographically comparable non-caregivers. Since self-reported health status is ordinal, we used ordinal logistic regression GLM to model this outcome. Higher values of the outcome variable indicated worse self-reported health. Parameter estimates for these models will be the expected difference in odds of reporting increased self-reported health comparing caregivers to non-caregivers, accounting for confounders.

Hypothesis 2: Caregivers will be less likely to exercise than demographically comparable non-caregivers. For the binary outcome of exercise in the past month, standard logistic regression GLM was used. The adjusted odds ratios, the exponentiated parameter estimates accounting for confounders, above 1.0 indicate that caregivers are more likely to have exercised than non-caregivers; odds ratios below 1.0 indicate the opposite.

Hypothesis 3: Caregivers will have a greater number of days of poor mental health than demographically comparable non-caregivers. Poisson models were used to assess the association between caregiving and the number of days of poor mental health outcome, a count variable with a strongly right-skewed distribution. Model-based exponentiated parameter estimates, or relative risks, indicate the expected multiplicative increase or decrease in number of days of poor mental health comparing caregivers to non-caregivers, also accounting for confounders in the model.

Sample size considerations. The unweighted sample size of the 2009 BRFSS is fixed, so for the power calculation, we assumed that power can vary, but the sample size must remain the same. We considered each outcome separately, but present the findings of the most conservative power calculation, for the outcome of number of days of poor mental health. A Poisson regression of a dependent variable of counts with the binary exposure variable of caregiving with proportion = 0.255 using a sample of approximately 380,000 observations with complete data achieves 90% power at a 0.050 significance level to detect a response rate ratio of at least 1.07, due to a one-unit change in the proportion caregiving. The sample size was adjusted since a multiple regression of

the covariate of interest on the other covariates in the Poisson regression is expected to have an R-Squared of 0.45.

Results

Using the BRFSS to define caregiving, 109,174 are categorized as informal caregivers, while 317,476 are non-caregivers. Descriptive statistics for the sample analyzed in this study are found in **Table 1**. In general, comparing caregivers to non-caregivers, caregivers are slightly younger, have slightly higher BMI values, are more likely to be female than male, and are more prevalent in rural areas compared to urban or intermediate areas of the country. In fact, each 10,000 people per square mile reduction in population density increased the likelihood of caregiving by 0.5% ($p < 0.001$). The relationship between caregiving and income is more complex. Caregiving was most prevalent in the middle-income categories ($25,000–50,000 and $50,000–75,000) than in the highest and lowest income categories. Blacks were 19% more likely than Whites ($p < 0.001$), and 76% more likely than Asians ($p < 0.001$) to be caregivers.

For outcomes of interest, caregivers were more likely to have exercised in the past 30 days, and had about one more day of poor mental health in the past month, on average, compared to non-caregivers. The association between self-reported health status and caregiving was not linear. Caregivers were slightly less likely to report their health as “excellent” than non-caregivers, yet were also 30% less likely to report their health on the other end of the health spectrum as “poor” compared to non-caregivers. Caregivers were more likely to report their health as either “very good”, “good”, or “fair”, than their non-caregiver counterparts. All comparisons were statistically significant at the $p < 0.001$ level, which is likely a consequence of the large sample size used in the analysis.

Table 2 shows the results of GLM parameter estimates for the three outcomes of interest: self-reported health status, exercise, and days of poor mental health. Four models are shown for each outcome. Model 1 shows the crude association between caregiving and each outcome variable. Model 2 includes several selected confounders—age, sex, income level, BMI, and

race/ethnicity. Model 3 contains all predictors in Model 2, with the inclusion of indicator variables for rurality tertile. Lastly, Model 4 contains all predictors in Model 3, except that in Model 4, there are two interaction terms designed to quantify the potential for the relationship between caregiving and each of the outcomes modified by rurality, using rurality tertile.

The first outcome of interest is self-reported general health status using ordinal logistic regression. Since health status is coded 5 for poor health, and 1 for excellent health, positive estimates of betas indicate detrimental risk factors that increase the likelihood of poorer health, while negative estimates of betas indicate protective associations between the exposures and health status. To that end, in the unadjusted model (Model 1), caregiving is actually negatively associated with poorer health status, suggesting a protective effect. However, once we adjust for covariates and confounders in Model 2, the association becomes positive and highly statistically significant. Age, BMI, Black race, Asian race, and other races are associated with an increased likelihood of poorer self-reported health, while female sex and higher income are associated with a reduced likelihood of poorer self-reported health. Compared to those living in urban areas, individuals in rural and intermediate settings tend to report poorer health, while the other associations remained statistically significant and in the same direction, as shown in Model 3. These relationships between the aforementioned social, economic, demographic covariates remain significant in Model 4, which assesses effect modification by rurality. Neither interaction term was significant, suggesting that there is no substantial effect modification of self-reported health by rurality.

Exercise status is the next health outcome examined in this analysis. In the table, odds ratios predicting exercise status are provided for this variable. Therefore, odds ratios above 1 indicate positive predictors of having exercised. The results suggest that caregivers are actually more likely than non-caregivers to have exercised in the past 30 days. This relationship held nearly steady, even after adjusting for multiple confounders and covariates, and after including interaction terms to assess effect modification. Interestingly, there was a statistically significant, positive interaction between caregiving and intermediate rurality, indicating that the likelihood of

caregivers exercising is significantly higher in areas of intermediate rurality than in urban areas. It should also be noted, however, that residents of rural and intermediate areas were less likely to exercise than their urban counterparts (Models 3 and 4).

Poisson regression was used to assess the associations between caregiving and number of days of poor mental health in the past 30 days prior to the interview date. As with the self-reported health variable, positive betas indicate potential risk factors for an increased number of poor mental health days. Caregiving is significantly and positively associated with number of days of poor mental health, even after controlling for confounders. Other risk factors include being female and BMI. Age, being of Black or Asian race, and being from a rural or intermediately rural area are actually protective and statistically significant in all models where included. There was a statistically significant and negative interaction between caregiving and rurality tertile, suggesting that living in rural areas mitigates the potentially detrimental association between caregiving and number of days of poor mental health to a small, but significant degree.

The models in **Table 3** use the same set of covariates as in Model 2 shown in **Table 2**, but here they are stratified by rurality tertile. This method of display allows us to view the association of all covariates and the main effect of caregiving on each of the health outcomes, and assess qualitatively if any associations are modified by rurality. For example, for self-reported health status, the protective effect of female sex on this outcome is 39% stronger in rural areas than in urban areas, while the harmful association between BMI and health is approximately 11% stronger in urban areas than rural areas. Most notably, the association between caregiving and self-reported health depends upon rurality. In the intermediate rurality areas, the association between caregiving and health is not statistically significant, while that same association is statistically significant in both the rural and urban tertiles. The association is actually nearly 70% stronger in urban areas than in rural areas. For other variables, the associations between the covariates and self-reported health did not differ substantially by rurality tertile stratum.

The same generally holds true for the exercise outcome: the relationships between each of the exposures and covariates, including caregiving, and exercise were fairly consistent throughout

strata. However, the associations between Asian race and exercise status were not significant in rural areas, but became more pronounced and statistically significant with increasing urbanicity. Similar results were found comparing “other” races to Whites. For the outcome of days of poor mental health in the past month, there was a statistically significant, positive association between caregiving and number of days of poor mental health. The magnitude of the association increased slightly as urbanicity increased, but remained significant in all strata. The protective relationship between Asian race and number of days of poor mental health was nearly twice as strong in urban and intermediate areas than in rural areas. This association was significant for all three rurality tertiles, however.

Discussion

This is the first study to employ the 2009 Behavioral Risk Factor Surveillance System to assess the associations between caregiving and three health outcomes on a national scale and assess how the associations between caregiving and multiple health outcomes differ by rurality. We found that the relationships between the outcomes of self-reported health, exercise, and mental health and the exposure of caregiving varied by rural-urban status, but the direction, magnitude, and extent of the associations were not consistent across all outcomes.

There are several important limitations to consider when interpreting the findings of this study. First, the data used in this study were abstracted from the BRFSS, and are cross-sectional. At this stage, the results of this analysis suggest that there are several distinct, statistically significant associations between caregiving and the three outcomes examined. An example of this occurs in the models that contain BMI as an exposure and exercise status as an outcome. It is widely accepted that exercise generally influences BMI, while the reverse of which is more difficult to prove.

Other limitations concern the way in which the variables used were measured and analyzed in this study. First, all data are self-reported, and are, therefore, prone to measurement error and potential misclassification. However, there is little reason to suspect that these potential

misclassification patterns in the self-reported health outcomes would differ with respect to exposure status. Exercise status was measured in the BRFSS as a dichotomous variable (yes/no). The distribution of exercise duration and intensity among those responding "yes" to this question is likely to vary substantially. A participant who, for instance, engages in low-impact exercise for 30 minutes a day and has been doing so for one month prior to the date the survey was administered and a second participant who engages in hours of rigorous daily activity for several years would both be categorized as exercisers in this analysis.

The primary exposure, caregiving, itself, may be prone to misclassification with respect to inclusion and exclusion criteria. The objective of this study is to study informal caregivers who provide care to older adults. However, the dichotomous caregiver variable representing the primary exposure likely contains some participants who provide care to young people, namely children and grandchildren. In 2009, the BRFSS included a detailed Caregiver Module asked of a sample of over 4,000 individuals in three states who responded "yes" to the caregiver question asked of all participants. One of the questions asked about their relationship to the care recipient. Of the caregivers in the three states, 8.5% responded that the care recipient was a child or grandchild. If this figure is applied to the entire group of caregivers nationally, we can infer that approximately 9,000 of the 109,174 caregivers provided care to non-elderly adults, and the representation is unlikely to change.

Another limitation involves the manner in which rurality was assessed. For interpretability, US counties were categorized into rurality tertiles, based on population density for this analysis. Counties at the first and 33rd percentiles of population density would both be classified in the first tertile, or "rural" counties, despite the fact that the county at the 33rd percentile likely has a more similar population density to a county in the 34th percentile than the first percentile. Under this scenario, counties at the 33rd and 34th percentiles would be categorized into separate rurality tertiles. Also, applying the rurality classification to all individuals living in one county ignores the within-county variability not only in population density, but also unmeasured features such as access to care, social support, and infrastructure. Moreover, in this analysis, the third tertile or the

set of “urban” counties was used as the reference group to determine if the associations between caregiving and the three health outcomes are more pronounced in rural areas compared to urban areas. However, urban and suburban residents are subject to well-documented health issues themselves.

Despite the limitations of this analysis, this study will help to provide the basis for future research on caregiving. Although in this analysis, we examined only three representative health outcomes, future studies can examine the multiple additional health outcomes that are also available in the BRFSS and other databases. These outcomes include measures of dietary quality, immunizations, sleep, stress, and alcohol consumption, among many others. The extent to which the relationships between specific aspects of caregiver health and preventive health behaviors and caregiving depend upon sociodemographic factors is not well known. Our study has the potential to meaningfully advance research and policy on informal caregiving because it compares the health of informal caregivers to non-caregivers, evaluates how these associations between caregiving and health vary by demographic factors, and is conducted at the national level. Understanding these potentially complex relationships and preparing for the challenges the next generation of informal caregivers will endure are critical issues facing public health today. Assessing the specific impacts of caregiving on caregiver health is essential to formulating effective policy to protect the health of the millions of informal caregivers who provide this invaluable service to care recipients and to society. Furthermore, the Federal Interagency Forum on Aging Related Statistics (2010) has characterized the need to understand the changing scope and outcomes of informal caregiving as a national need.

Our analysis considered caregiving as a binary variable, inclusive of all caregivers, regardless of the intensity of caregiving or the health conditions of the recipient requiring care. Substantial variation exists in the population of caregivers (Bertrand, et al., 2006). To address this important issue, for the first time, publicly-available 2009 BRFSS data included a detailed Caregiver Module asked in three states and districts, the District of Columbia, Illinois, and Louisiana. The Caregiver Module included detailed information asked of over 4,000 participants in

those states who responded “yes” to the original caregiver question asked of all BRFSS participants nationally. Questions pertained to the nature, the intensity and duration of the caregiving relationship, the major health issues the recipient have that requires informal caregiving, and recent cognitive changes in the care recipient. The release of the 2010 BRFSS data set included a new version of Caregiver Module asked in two states, Connecticut and New Hampshire. Although the sample size is greatly reduced compared to the entire national BRFSS sample, the remaining sample of over 4,000 participants in the Caregiver Module provides a vital and rich source of data that can be used to profile the health of informal caregivers in future studies, and examine the potentially complex relationships between intensity of caregiving and multiple health outcomes.

Future research in this field can also delve deeper into those sociodemographic factors that alter the associations between caregiving and health. Such studies can take into account the effect of these modifying factors not only on the aggregate level, as was done in our study, but also on the individual and aggregate levels simultaneously using multi-level modeling techniques for correlated data. Additionally, potential future studies can examine the issue of caregiver health beyond individual outcomes by examining patterns or domains of health outcomes and caregiving using latent class analysis and structural equation modeling (Savundranayagam, et al., 2011).

The findings of this study provide a preliminary understanding of how unmet healthcare needs and the relationships between caregiving and health vary geographically and demographically. If these findings are verified in future studies, the next step will be to ascertain the specific mechanisms that drive these associations. A comprehensive review comparing rural to urban areas concluded that although differences in caregiver health exist, it remains difficult to precisely ascertain the specific elements of rural health that truly influence informal caregiving (Goins, et al., 2009; House, et al., 1998). One possibility is social support. In one rural health study, rurality was associated with significantly reduced social support, lower overall quality-of-life, and reduced functional well-being in a sample of women after receiving treatment for breast cancer (Reid-Arndt, et al., 2010). To date, however, there are few studies that have directly linked social

support to rural health outcomes in older adults. Another possibility is reduced access to and usage of health care services in rural communities compared to more urban areas (Clark & Dellasega, 1998; Blazer, et al., 1995). However, it remains unclear if these or other aspects of the rural environment are responsible for the variation in the observed associations between caregiving and health outcomes by rurality in our study.

We expect the findings of this study will initiate further research into this vital aspect of the health care delivery system. With population aging and increasing longevity in the US, the role informal family caregivers play for both the individual care recipients and for the health care system cannot be overlooked. Protecting the health of over 50 million informal US caregivers who provide this crucial service is integral not just to the caregivers themselves and the national economy, but also to the recipients of care. Ensuring that caregivers are healthy, supported, and well-equipped to handle the challenges of caregiving enhances the quality of care they provide, and reduces the risk of anger, depression, and associated elder abuse (MacNeil, et al., 2010; Shaffer, et al., 2007). Identifying and ultimately targeting those populations of informal caregivers most impacted by caregiver burden, based on rurality, is an integral step in improving the caregiver experience and protecting this important resource as the population ages for generations to come.

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Tables

Table 1: Descriptive statistics for outcome and exposure variables, overall and by caregiver status

Variable	*Overall*	*Caregivers*	*Non-caregivers*	*p-value**
	Mean (SD)			
N	**292,813**	**74,135**	**218,678**	
Age	55.8 (16.5)	55.0 (14.7)	56.1 (17.1)	< 0.001
BMI	27.7 (6.0)	27.9 (6.0)	27.6 (6.0)	< 0.001
Number of days of poor mental health	3.4 (7.8)	4.4 (8.7)	3.4 (7.4)	< 0.001
	N (%)**			
Sex	**292,813**			
Male	110,162 (37.6)	23,972 (32.3)	85,366 (39.4)	< 0.001
Female	182,651 (62.4)	50,163 (67.7)	131,286 (60.6)	
Annual income	**255,719**			
< $25,000	73,451 (28.7)	17,609 (26.7)	55,385 (29.4)	< 0.001
$25,000 – 50,000	68,543 (26.8)	18,596 (28.2)	49,558 (26.3)	
$50,000 – 75,000	41,477 (16.2)	11,127 (16.9)	30,115 (16.0)	
≥ $75,000	72,248 (28.3)	18,532 (28.1)	53,277 (28.3)	
Race	**290,184**			
White	247,515 (85.3)	62,768 (84.7)	185,596 (85.7)	< 0.001
Black	27,105 (9.3)	7,732 (10.4)	19,245 (8.9)	
Asian	3,846 (1.3)	707 (1.0)	3,105 (1.4)	
Other	11,718 (4.1)	2,928 (3.9)	8,705 (4.1)	
Rurality	**292,813**			
Rural	97,862 (33.4)	25,732 (34.7)	71,525 (33.0)	< 0.001
Intermediate	97,710 (33.4)	24,781 (33.4)	72,332 (33.4)	
Urban	97,241 (33.2)	23,622 (31.9)	72,795 (33.6)	
General health status	**290,909**			
Excellent	53,067 (18.2)	13,067 (17.7)	39,575 (18.4)	< 0.001
Very good	93,348 (32.1)	24,117 (32.7)	68,640 (31.9)	

Good	88,336 (30.4)	23,022 (31.2)	64,714 (30.1)	
Fair	39,367 (13.5)	10,073 (13.7)	29,014 (13.5)	
Poor	16,791 (5.8)	3,452 (4.7)	13,219 (6.1)	
Exercise in past 30 days	**292,818**			
Yes	212,847 (72.7)	56,703 (76.6)	154,671 (71.5)	< 0.001
No	79,630 (27.2)	17,355 (23.4)	61,727 (28.5)	

*P-values compare caregivers to non-caregivers using Wilcoxon Rank Sum test for age, BMI, number of days of poor mental health, general health status, and chi square for all other variables.

** Some total Ns do not match the sum of Ns by caregiver status due to missing data.

Table 2: Model estimates and odds ratios from generalized linear models of three outcomes: General health (1 = excellent, 5 = poor), exercise status (yes/no), and days of poor mental health in the past month

General Health (Ordinal Regression)	**Beta (95% Confidence Interval)**			
Variable	***Model 1***	***Model 2***	***Model 3***	***Model 4***
Caregiving	-0.019 (-0.034, -0.004)	0.037 (0.020, 0.053)	0.034 (0.017, 0.050)	0.056 (0.027, 0.085)
Age		0.020 (0.019, 0.020)	0.020 (0.019, 0.020)	0.020 (0.019, 0.020)
Female sex		-0.146 (-0.161, -0.131)	-0.145 (-0.160, -0.130)	-0.145 (-0.160, -0.130)
Income		-0.329 (-0.332, -0.325)	-0.326 (-0.329, -0.322)	-0.326 (-0.329, -0.322)
BMI		0.074 (0.072, 0.075)	0.073 (0.072, 0.075)	0.073 (0.072, 0.075)
Race (ref = White)				
Black		0.198 (0.172, 0.224)	0.224 (0.198, 0.250)	0.224 (0.198, 0.250)
Asian		0.269 (0.206, 0.333)	0.299 (0.235, 0.363)	0.300 (0.236, 0.364)
Other		0.352 (0.313, 0.390)	0.352 (0.314, 0.390)	0.352 (0.314, 0.390)
Type of county (ref = Urban)				
Rural			0.112 (0.094, 0.131)	0.120 (0.099, 0.141)
Intermediate			0.046 (0.028, 0.063)	0.055 (0.034, 0.075)
Interactions				
Caregiving*Rural				-0.029 (-0.070, 0.011)
Caregiving*Intrm				-0.036 (-0.077, 0.005)

Exercise (Y/N) (Logistic Regression)	**Odds Ratio (95% Confidence Interval)**			
Variable	***Model 1***	***Model 2***	***Model 3***	***Model 4***
Caregiving	1.30 (1.28, 1.33)	1.28 (1.25, 1.31)	1.28 (1.25, 1.31)	1.22 (1.18, 1.27)
Age		0.99 (0.99, 0.99)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)
Female sex		0.86 (0.84, 0.88)	0.86 (0.84, 0.87)	0.86 (0.84, 0.87)
Income		1.23 (1.23, 1.24)	1.23 (1.22, 1.23)	1.23 (1.22, 1.23)
BMI		0.95 (0.95, 0.95)	0.95 (0.95, 0.95)	0.95 (0.95, 0.95)
Race (ref = White)				
Black		0.82 (0.79, 0.84)	0.80 (0.78, 0.83)	0.80 (0.78, 0.83)
Asian		0.79 (0.72, 0.86)	0.77 (0.71, 0.84)	0.77 (0.70, 0.84)

Other	0.85 (0.81, 0.89)	0.85 (0.81, 0.89)	0.85 (0.81, 0.89)
Type of county (ref = Urban)			
Rural		0.93 (0.90, 0.95)	0.92 (0.89, 0.94)
Intermediate		0.97 (0.95, 0.99)	0.95 (0.92, 0.98)
Interactions			
Caregiving*Rural			1.05 (0.99, 1.11)
Caregiving*Intrm			1.09 (1.03, 1.16)

Days of poor mental health

(Poisson Regression) Beta (95% Confidence Interval)

Variable	***Model 1***	***Model 2***	***Model 3***	***Model 4***
Caregiving	0.361 (0.356, 0.365)	0.344 (0.340, 0.349)	0.346 (0.342, 0.351)	0.352 (0.344, 0.360)
Age		-0.016 (-0.016, -0.016)	-0.016 (-0.016, -0.016)	-0.016 (-0.016, -0.016)
Female sex		0.244 (0.239, 0.248)	0.243 (0.238, 0.248)	0.243 (0.238, 0.248)
Income		-0.197 (-0.198, -0.196)	-0.199 (-0.200, -0.198)	-0.199 (-0.200, -0.198)
BMI		0.017 (0.017, 0.017)	0.017 (0.017, 0.018)	0.017 (0.017, 0.018)
Race (ref = White)				
Black		-0.158 (-0.164, -0.151)	-0.178 (-0.185, -0.171)	-0.178 (-0.185, -0.171)
Asian		-0.329 (-0.352, -0.306)	-0.355 (-0.378, -0.333)	-0.355 (-0.378, -0.332)
Other		-0.003 (-0.013, 0.006)	-0.006 (-0.015, 0.004)	-0.005 (-0.015, 0.005)
Type of county (ref = Urban)				
Rural			-0.093 (-0.098, -0.088)	-0.089 (-0.095, -0.082)
Intermediate			-0.047 (-0.052, -0.042)	-0.045 (-0.052, -0.039)
Interactions				
Caregiving*Rural				-0.012 (-0.023, -0.001)
Caregiving*Intrm				-0.004 (-0.016, 0.007)

Table 3: Model estimates and odds ratios from generalized linear models of three outcomes: General health (1 = excellent, 5 = poor) exercise status (yes/no), and days of poor mental health in the past month stratified by rurality tertile

General Health

(Ordinal Regression) Beta (95% Confidence Interval)

Variable	*Rural*	*Intermediate*	*Urban*
Caregiving	0.031 (0.003, 0.059)	0.020 (-0.009, 0.049)	0.052 (0.022, 0.081)
Age	0.020 (0.019, 0.020)	0.019 (0.019, 0.020)	0.020 (0.019, 0.021)
Female sex	-0.167 (-0.193, -0.141)	-0.146 (-0.172, -0.120)	-0.120 (-0.146, -0.094)
Income	-0.331 (-0.338, -0.325)	-0.320 (-0.326, -0.313)	-0.326 (-0.332, -0.319)
BMI	0.070 (0.067, 0.072)	0.073 (0.071, 0.075)	0.078 (0.076, 0.080)
Race (ref = White)			
Black	0.207 (0.150, 0.263)	0.208 (0.160, 0.257)	0.239 (0.202, 0.276)
Asian	0.250 (0.053, 0.447)	0.251 (0.122, 0.379)	0.343 (0.263, 0.422)
Other	0.321 (0.263, 0.380)	0.297 (0.221, 0.373)	0.431 (0.364, 0.498)

Exercise (Y/N)

(Logistic Regression) Odds Ratio (95% Confidence Interval)

Variable	*Rural*	*Intermediate*	*Urban*
Caregiving	1.28 (1.23, 1.33)	1.33 (1.28, 1.38)	1.22 (1.18, 1.27)
Age	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)
Female sex	0.89 (0.86, 0.92)	0.85 (0.82, 0.88)	0.83 (0.80, 0.86)
Income	1.22 (1.21, 1.23)	1.24 (1.23, 1.24)	1.23 (1.23, 1.24)
BMI	0.95 (0.95, 0.95)	0.95 (0.95, 0.95)	0.95 (0.95, 0.95)
Race (ref = White)			
Black	0.85 (0.79, 0.91)	0.81 (0.76, 0.86)	0.78 (0.75, 0.82)
Asian	1.00 (0.76, 1.31)	0.82 (0.69, 0.97)	0.70 (0.63, 0.78)
Other	0.98 (0.91, 1.05)	0.90 (0.81, 0.98)	0.69 (0.63, 0.74)

Days of poor mental health

(Poisson Regression) Beta (95% Confidence Interval)

Variable	*Rural*	*Intermediate*	*Urban*
Caregiving	0.341 (0.334, 0.349)	0.347 (0.339, 0.355)	0.353 (0.345, 0.361)
Age	-0.017 (-0.017, -0.017)	-0.016 (-0.016, -0.016)	-0.015 (-0.015, -0.015)
Female Sex	0.249 (0.241, 0.257)	0.274 (0.266, 0.282)	0.210 (0.202, 0.218)
Income	-0.208 (-0.209, -0.206)	-0.199 (-0.201, -0.197)	-0.191 (-0.192, -0.189)
BMI	0.016 (0.015, 0.016)	0.017 (0.016, 0.017)	0.020 (0.020, 0.021)
Race (ref = White)			
Black	-0.223 (-0.238, -0.208)	-0.196 (-0.209, -0.183)	-0.145 (-0.155, -0.135)
Asian	-0.198 (-0.263, -0.132)	-0.361 (-0.406, -0.315)	-0.370 (-0.398, -0.341)
Other	0.000 (-0.015, 0.014)	-0.008 (-0.027, 0.012)	-0.007 (-0.023, 0.010)