How does community density influence resident health?

by

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A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF REGIONAL AND COMMUNITY PLANNING

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KANSAS STATE UNIVERSITY
Manhattan, Kansas

2021

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Abstract

Community density and public health have a long history that can be traced back to the birth of civilization. Across the world cities of different sizes can be drastically different in terms of overall public health, and this is primarily related to what the World Health Organization calls Indicators of health. They define health as “a state of complete physical, mental and social well-being”. Understanding how variations in density can influence the population’s overall health opportunities can benefit many future professionals across a broad spectrum of professions. This report brings both topics together to show how different variations in density can influence the overall health and well-being of the public. By defining three different density measurements and combining them with the Center for Disease Control’s “Social Determinants of health” we can get a clearer view of how density can impact opportunities for the public’s health outcomes.

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Acknowledgements

First, I would like to acknowledge and thank Kansas State University as a whole for providing me with an environment for a memorable academic career. I deeply thank the faculty and staff of the College of Architecture, Planning, and Design as well for helping me complete my academic goals. Every assignment, project, and task I was given has or will serve a purpose in my acceleration as an educated member of our society and my profession.

Second, I will also point out the effort the college has put forth in making sure the COVID-19 pandemic has not negatively affected my ability to learn and complete my degree. The switch to online classes for the final year of my graduate study was a very difficult reality to accept. But the faculty and staff of the department have made those troubles nearly eliminated through proper online collaboration and guidance.

Finally, I would like to acknowledge and thank my peers in my degree for giving me a fun and collaborative work environment for intelligent conversations and community support to enhance my overall academic experience.

1 - Introduction

The relationship between community density and public health can be seen throughout the entire evolution of cities. Since the beginning of organized human civilization, we have oriented ourselves with some sort of density control in place whether its ancient farms in the Fertile Crescent or the urban centers of Rome. Basic human cities have developed with each land use associated to a specific type of resident density: low density for farming, medium for housing, and high for commerce & government. In 1925, Burgess proposed a descriptive urban land use model that divided cities into concentric circles starting with a dense urban core and expanding upward to lower dense rural farms (Anon, 2017). Commute times increased and access to amenities decreased the further out you traveled. Throughout our history especially in the United States we have molded our cities into similar concepts based off the concentric circles model from Burgess. The idea of having a high-density urban core surrounded by decreasing density circles as the land use changes has been our model for decades. Urban planners and designers use this model to explain small urban concepts used for more complex applications. One of those applications is the relationship between health and density. Back then health was a much more complicated issue as higher density areas were riddled with diseases and overcrowding.

Public health was a struggle in early civilizations mainly due to the lack of medical knowledge we have today. Methods for treatment on basic illness such as the flu were based off little research and assumptions. Some people would get lucky and recover but many would not survive. As history progressed, we slowly developed new technology to reduce the impacts of illnesses and increase overall life expectancy. The physical and emotional well-being of individuals is key to constructing and maintaining the longevity of a civilization.

Today population density has been a measurement used by professionals in all sorts of fields for either objective or subjective measures. Every measure of density has certain assumptions and accusations when it comes to its link to the overall public health. For example, some assume higher density areas have healthier people since walkability is said to be higher. Then some say rural communities are healthier since more physical professions are found such as agriculture production. On the opposite side of the argument some studies found that high density urban environments generally show low subjective measures of life satisfaction which is a large factor in overall health (Ballas, 2013).

Urban sprawl has caused communities to expand across the horizon and that has made planning even more difficult. Amenities are now further apart, and the territory covered by a city gets larger every day. Planning for an environment that will maximize someone's ability to be healthy and happy should be the top priority in every business that makes up a city. It is important a clear connection is established between these topics to avoid an increase in severe health problems.

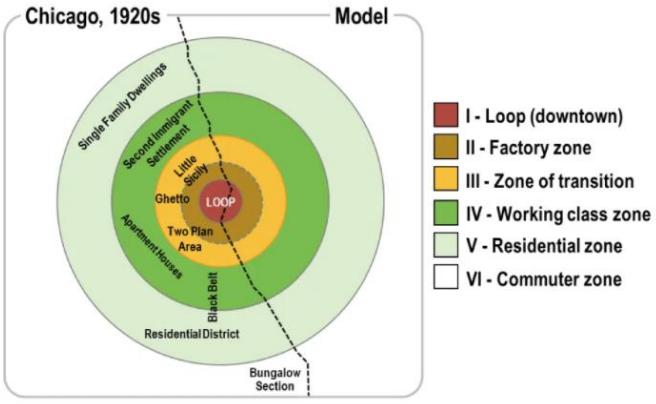

Figure 1.1: Concentric circles model, Burgess, (transportationgeography.org)

2 - Literature Review

Health for this study will have its own set of categories which will be taken directly from the World Health Organization and CDC's Social Determinants of Health (SDOH) (Centers for Disease Control and Prevention, 2020). They are defined as the conditions in which people are born, grow, live, work, and age in our modern society. The distribution of money, power, and resources throughout local communities, nations, and the world is what shapes these outcomes. Very strong theories and better policy recommendations can be made when the knowledge of community well-being is spread (Lawless & Lucas, 2011). These determinants include income and social protection, education, unemployment and job security, food insecurity, housing, basic amenities and the environment, early childhood development, social support and inclusion, structural conflict, and access to health services (World Health Organization, 2020). High density areas typically have better physical well-being results than compared to low density, but the opposite is true for mental health as low density is higher (Fassio, Rollero, & De Piccoli, 2013). This is tied to commute times which have been said to have a large impact on well-being results as well (Lawless & Lucas, 2011).

Figure 2.1: Social Determinants of Health (Center for Disease Control)

Income is a significant predictor for all quality-of-life components not just health (Fassio, Rollero, & De Piccoli, 2013), and with income variation comes poverty. The positive relationship between income and overall health has been covered in many studies and literature (Carrieri & Jones, 2017). More income allows for more basic needs to be met (Lawless & Lucas, 2011) and more opportunities to afford proper healthcare such as insurance, well trained physicians, and access to top-shelf medicine. The inequality of socioeconomic classes is closely linked to health disparities across many nations in the modern era (Byhoff, Hamati, Power, Burgard, & Chopra, 2017). However, some studies (Khaled, Makdissi, & Yazbeck, 2018) show socioeconomic variables to have little effect on someone's well-being then compared to more subjective social concerns. The overall health of people in poverty is a strong policy topic which many nations have their own ways of dealing with. Median household income (MHI) almost always increases alongside an increase in density (Fassio, Rollero, & De Piccoli, 2013). Relating back to income/socioeconomic class is educational attainment which has a strong positive correlation with median household income (Byhoff, Hamati, Power, Burgard, & Chopra, 2017). Higher paying wages stem from increased educational backgrounds which are more prevalent in higher density areas. This allegedly affects health opportunities for an individual or family as well (Carrieri & Jones, 2017).

The environment in which someone lives plays a large role in the physical health of an individual's life (Fassio, Rollero, & De Piccoli, 2013), which quality housing and amenities make those opportunities more abundant. Urban areas have much greater access to higher education institutions, retail and commercial connections, transportation options, park/plaza variations, and housing opportunities both affordable and luxury. Denser areas also have more energy efficient housing such as large apartment/high-rise complexes then compared to suburban

and rural single-family residences that are much less energy efficient (Borck & Schrauth, 2021). In the last few decades urban sprawl has been seen to cause a decrease in overall activity levels as a result of the evolving built environment (Frumkin, 2002). A study in 2005, found that adults living in sprawling counties have a higher body mass index on average, and are more likely to be obese than their counterparts living in compact counties (Ewing, Meakins, Hamidi, & Nelson, 2014). However, neighborhood amenities have been seen to decrease obesity levels of the youth by a relatively substantial amount (Pitts, et al., 2013). This is due to the access of recreational facilities and programs in most rural communities being much lower than compared to urban or suburban (Lim et al. 2017). Social and mental health however has been seen to be much higher in rural environments with people being very attracted to trees, birds, flowers, etc (Frumkin, 2002).

The access to healthcare facilities is also vital for creating and maintaining a healthy and sustainable population/community. Higher density urban environments have a much shorter average drive time to the nearest hospital then rural or suburban communities do (Lam, Broderick, & Toor, 2018). This poses an issue for many rural communities since the nearest hospital or extensive care facility is not in easy reach. Much higher health disability rates are found in rural America as well so that does not seem rational (Reichert & Berry, 2019). A small clinic is usually located in a rural community, but any major emergencies are usually out of the clinic's ability. This makes automobiles the primary form of transportation found in most rural areas which obviously has its pros and cons. In the United States automobiles are the most popular choice no matter the population density. Air pollution is also a health factor and concern mainly due to automobile use and relates to how dense an area is. However, population size has been found to be positively correlated with pollution, but density is sometimes found to be

negative (Borck & Schrauth, 2021). If the public continues to choose their own automobiles for commutes instead of using public transit then higher density areas will always be associated with higher pollution (Borck & Schrauth, 2021).

The access to healthy food producers is also to be considered and can vary depending on available shopping budgets. Budgets then link back median household income and its ability to increase health opportunities (Lawless & Lucas, 2011). More healthy grocery providers with organic or non-GMO products usually charge much higher prices than your local grocery commercial store will. This break of income disparity (Carrieri & Jones, 2017) causes lower income families to be forced into unhealthier food options (Byhoff, Hamati, Power, Burgard, & Chopra, 2017). The U.S News and World Report database uses a measurement called the Food Environment Index which indicates how accessible healthier foods are to the population. Higher scores mean healthy foods are more available than unhealthy foods. High density areas usually score mush higher than rural (U.S. News and World Report, 2020). Rural communities struggle since grocery amenities are much more limited. Any fresh produce usually must be grown by homeowners, which makes subsistence agriculture and practices much more popular in these communities.

The final indicator used by the CDC for determining overall health is based on social capital. High density environments offer lots of opportunity for social capital improvement but tend to fall behind the progress of smaller suburban and rural communities. Some say its due to the traditional viewpoint of urban space, which is typically shallow, short-lived, and formal because of the size, density, and heterogeneous social nature of the city (Lannoo, Verhaeghe, Vandeputte, & Devos, 2012). Leadership development in suburban and rural communities is shown to be higher as well (Eckert, 2019). Children are more likely to be members of a school

group than those in large metropolitan and urban areas (McIntosh, Kenny, Masood, & Dickson-Swift, 2019). The more positive culture, social conditions, and administrative politics of suburban communities allows for more collective leadership capacity, practice, and student-focused outcomes (Eckert, 2019). Urban relationships in general tend to be more acquaintance and friendship tied to the workplace rather than family, neighborhood, and small organizational relationships found in rural environments (Lannoo, Verhaeghe, Vandeputte, & Devos, 2012).

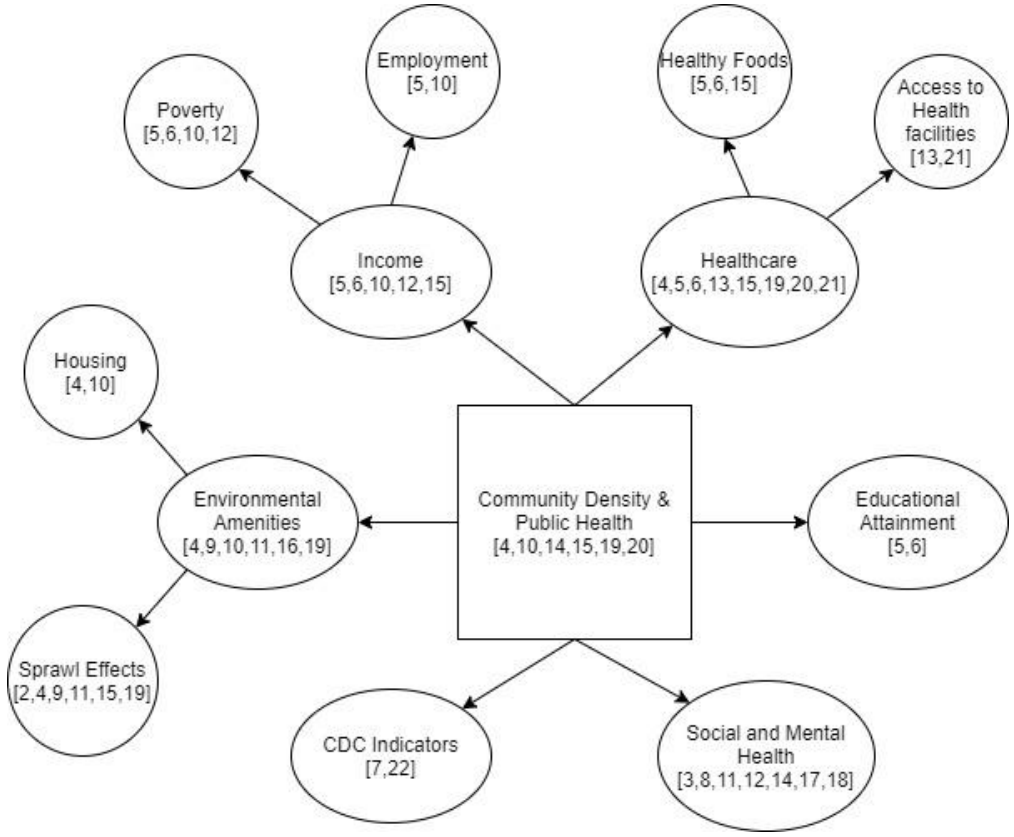

Figure 2.2: Literature Diagram/Plot

1. APA. (2017)	9. Ewing, R., Meakins, G., (2014)	17. McIntosh, K., Kenny, A.,(2019)
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6. Carrieri, V., & Jones, A. M. (2017)	14. Lannoo, S., Verhaeghe, P.(2012)	22. World Health Organization(2020)
7. Centers for Disease Control (2020)	15. Lawless, N. M., & Lucas, (2011)	
8. Eckert, J. (2019)	16. Lim, K., Kwan, Y., (2017)	

3 - Methods

This research focuses on Pearson correlation results from combining the quantitative datasets found from the US census bureau and other sources to highlight connections. This approach allows for many connections to be made between several factors. This method of applied research breaks down two or more characteristics. The variables included are the three density measurements as well as the CDC's indicators of health. Each density will have its own set of indicators that will then be used to compare across the other two densities. By breaking up each density through this method of research, we can pull out separate information as well as results from previous studies for each variate then bring everything together to explain connections and anomalies.

The Pearson correlation measures if there is a linear relationship between two sets of data. There will be several tests completed for this research, and once all the coefficient and p values have been determined we can build a table to visualize all correlations found between the variates. For example, one of the tests will be between population density (high, medium, and low values from census data) and the average drive to the nearest hospital (access to healthcare facilities). The coefficient from these tests will be between 1 and -1, with 1 being a perfect positive correlation and -1 being a perfectly negative correlation (zero being no correlation at all). These tests will be ran for each of the combinations with community density using Microsoft Excel as the software of choice. Some anomalies will be due to outside factors but for the purposes of this report we can understand the basic relationships between several characteristics and their connection back to the research question.

Data Variables

The locations for the density variables are at the county level with Johnson (High), Riley (Medium), and Chase county (low). Data for each health determinant will be linked to each of the three densities. All the necessary data has been found through various databases using the county scale. Databases such as the United States Census Bureau, US News and World Report, World Population Review, and the World Health Organization are the primary sources relevant for this report. Some categories have been combined to follow the indicators of health as described in the previous chapter. This will make the results and relevant data easier to read. These include: Income and poverty (median household income with poverty rates), Education and employment (percentage of diplomas and unemployment rates), Housing and environmental amenities (homeowner rates, housing value, and access to businesses/institutional facilities), and the last being Access to health amenities (average hospital commute, health insurance rates, and access to healthy foods).

Data tables

Table 3.1: County data comparison 1

County	Population	Area	Pop density	Pop growth2010	MHI	Poverty	Education%
Johnson	591,506	473.3	1249	11.18%	$89,087	5.37%	96%
Riley	75,056	609.9	123.12	2.41%	$51,208	22.40%	95.80%
Chase	2,637	772.9	3.41	-6.92	$45,353	11.80%	91.80%

Table 3.2: County data comparison 2

Unemployment	Housing value	Homeowner rate	No Health insurance	Drive to hospital	Food score
2.90%	$259,600	69.20%	5.90%	10.4	9.79
5.80%	$201,000	43.20%	9%	11.9	5.10
4.50%	$103,000	80.70%	10.40%	17	1.40

4 - Findings

The first calculations made were the correlation coefficients found when running the test in Microsoft Excel using the density and health variables. For example, the first coefficient is calculated by running the test with population density and median household income giving us a coefficient value of .999 which is almost perfectly positive. As expected, income is strongly positively correlated with density as a result of an increase in standard/cost of living. For reference again the coefficient from these tests will be between 1 and -1, with 1 being a perfect positive correlation and -1 being a perfectly negative correlation (zero being no correlation at all). The second calculation is the t statistic, which is found by plugging the coefficient values as well as a few other found known numbers into a specific formula. This value is used to run the final one-tailed distribution test to calculate the p values. The final p values that resulted from these tests were not significant since only three variables of density were used instead of a larger set of data. Because of this they will not be included in this report.

Table 4.1: Pearson Coefficients to community density

	Pop. Density
Median Household Income	0.999
Poverty	-0.731
Education Percentage	0.608
Unemployment	-0.852
Housing Value	0.836
Homeowner Rate	0.132
No Health Insurance	-0.976
Drive to nearest hospital	-0.737
Food Environment Index	0.933

When looking at how density influences resident's overall health the most attractive indicators from this test are the last three (health insurance, drive to nearest hospital, and food index). The other indicators are also valuable, but a larger data sample size (counties) would

have allowed a more accurate correlation to be made. This encourages and sets up other studies to be conducted following the same tests just with a higher number of counties. The percent of people without health insurance is much higher in rural Chase county (10.4%) which is a shock since there are much higher rates of disabilities in rural America than compared to urban. However, health insurance agencies may be harder to interact with the more rural you become which could explain the results. Having quality access to healthy food is a large plus for developing and maintaining a healthy lifestyle as well. The test/data reveals and supports the theories about how low-density rural communities lack proper access to healthy options. The U.S. and World Report scores Chase county much lower (1.4) than both Riley (5.1) and Johnson (9.79).

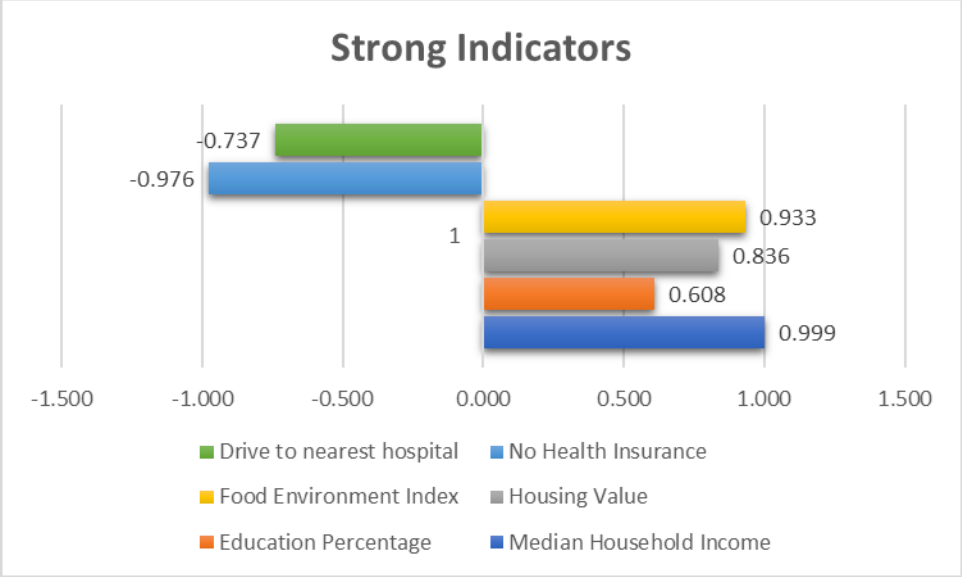

Figure 4.1: Strong Indicators of Health to Density

Poverty rates for the three counties are very different across the board as Riley has the highest (22.4%) which is higher than the US average (12.3%). This is probably due to the several colleges/technical schools found in the county which brings the measured poverty rates higher

even though those students probably are not working full time. Johnson county's poverty rate is much lower (5.37%) as the population is much higher, and the relative percentage of those below the poverty line is much smaller as well. Chase county sits in the middle at 11.8%. This can be an example of how poverty has much more external factors that effect it as does many of these variables.

Educational attainment follows a much more expected pattern as high density leads and low-density trails close behind in third. As explained in the literature higher paying jobs require a higher attained level of education and those jobs are primarily found in urban environments. Unemployment is similar to poverty in this case as Riley (5.8%) leads due to the high percentage of students in their population who are not participating in the workforce. A larger sample size of data/counties would need to be tested as said, in order to accurately make assumptions on poverty or unemployment's effect on health.

Housing value is closely related and can be linked back to median household income. This is another easily explainable finding from the data as home prices are primarily based on property values and structural condition. Chase county has the lowest property values and therefore having the lowest housing value as well (vice versa for Johnson county). Homeowner rates between the counties is seen to have little to zero correlation as the coefficient is barely above zero. Chase county having the highest homeowner rate and Riley having the lowest. The homes in rural areas are mostly passed down through family generations and are commonly used as permanent residences. More populated environments contain much higher renter percentages as the cost of owning a home is more expensive.

5 - Discussion

When looking at the results from these tests and using the known literature as guidance we can start to understand how density influences resident health. The cost of living in an area is responsible for many of the variations in the data found in the results. For example, we learned how median household income is strongly tied to density as this allows for more opportunities such as purchasing health care and shopping at healthier grocery stores. Income gives families and residents the power of choice which comes down to the individual's responsibility if they want to take care of their own health or not. Several health opportunities can be thrown at someone but if they choose to spend their money elsewhere then that is more of a psychological issue. The literature and test support that high density regions offer more opportunity for proper health maintenance but not everyone chooses to use them. This dilemma can be a valuable topic for further research to be conducted. As far as influencing a resident's health, density provides various foundations for growth. Density influences the access to healthcare facilities greatly by having a much shorter drive on average in urban than rural communities. However, this could be much different across other states. This study briefly shows when density increases, the drive to a hospital decreases. Some states may have a larger number of hospitals spread out across rural areas in their region, which would change their own averages. The overall access to amenities in general is seen to have an impact on health which lower density areas generally lack. However, there can be plenty of healthy people living in rural environments too. This goes back to the social dilemma of how people choose to spend their money on healthcare services or not. Lots of room for extra research can be drawn out of these results and literature connections.

Unemployment and poverty can be linked together as two more socio-economic indicators which affect health, and density is seen to be related to both. For this report

unemployment rates and poverty rates are affected by other factors in this case Riley's college student enrollment. Manhattan is the largest city and central hub in Riley and a large percentage of their population is students from Kansas State. A more proper experiment should be made with these too indicators since poverty and unemployment can vary across several cities/states. For relevance we can see how more jobs are available in higher density regions which traces back to health opportunities increasing too.

Together all of the indicators from this report stem back to how economically developed an area is. For example, density may not be the important factor when measuring how healthy an area is, but rather how economically developed it is instead. Rural areas could change these indicators and influence their community's health by bringing in certain development to supply more jobs which would increase median household incomes, lower unemployment, bring people out of poverty, and benefit the overall community. Individuals over time will be able to purchase proper healthcare, higher quality homes, and healthier foods to enhance their well-being. Adding in amenities to the community will not only boost economic vibrancy but also provide more foundations for social capital improvements as well. Which is a crucial part in supporting the longevity of an environment no matter the size/density. Giving a community the proper foundations for development will not only benefit current generations but future generations as well. This is the basic model for many cities Vision Plans across the nation. Each one wanting to bring in new development to supply residents with more economic opportunities which in turn should also influence overall public health.

For the planning world information regarding health concerns is always valuable and extremely useful. Planners make decisions that will lead to the best outcome for the welfare of the public. Under the AICP code of ethics, planners are held responsible for any short and long-

range concerns to the public and must pay special attention to the interrelatedness of decisions (American Planning Association, 2017). Controlling population density has been an objective in the planning world for quite some time and monitoring the health effects relates to its challenges. Public health is a topic that is always evolving and with the proper knowledge and rational decision-making professionals can enhance the community's overall well-being. This report showcases how density can change certain indicators of health, and in doing so influencing the overall health of the public. The results from the tests support many of the claims made by the current literature and indicating a pattern in how density alters the opportunities residents have to increase their health status. Several new doors have been opened from this research and other studies can soon start to be done. Combining even more literature with a more extensive data correlation, the relationship of how density influences resident health can be tightened. In conclusion, health indicators tend to change when density of an area changes as well. Higher density areas offer more health opportunities than rural but do not necessarily have healthier residents. It is more importantly a matter of enhancing the economic development in an area which is what all cities strive to achieve.

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Appendix

Comparing 3 Counties	Johnson County, KS	Riley County, KS	Chase County, KS
Overall Rank	#71	Not Ranked	Not Ranked
Overall Score	75.1	50	N/A
Peer Group	Urban, High-Performing	Urban, High-Performing	
Population Health			
Population Health Score	88.8	85.1	N/A
Access to Care Score	58.5	48.8	N/A
Hospital Bed Availability	2.5/1k	2.2/1k	0.0/1k
Population With No Health Insurance	7.2%	9.0%	10.3%
Primary Care Doctor Availability	1.8/100k	1.3/100k	0.0/100k
Health Behaviors Score	91.6	85.7	N/A
Adults With No Leisure-Time Physical Activity	17.2%	17.7%	22.7%
Medicare Beneficiaries With Recent Primary Care Visit	42.0%	45.0%	33.0%
Smoking Rate	12.0%	15.3%	15.5%
Health Conditions Score	59.3	73.7	N/A
Cancer Incidence Rate	N/A	N/A	N/A
Heart Disease Prevalence Among Medicare	26.0%	22.0%	24.0%

Table 0.1: Population statistics comparison (US News and World Report, 2020)

Education Score	74.8	69.3	N/A
Educational Achievement Score	81.1	64.9	N/A
Children Meeting Standards in Grade 4 ELA	64.7%	58.6%	44.6%
High School Graduation Rate	91.0%	82.0%	94.4%
Population With Advanced Degree	62.8%	53.7%	28.6%
Education Infrastructure Score	44.2	41.5	N/A
Child Care Facilities	1.8/100k	4.1/100k	0.0/100k
Per-Pupil Expenditures	$12,604	$11,879	$13,986
Youth Within 5 Miles of a Public School	100.0%	94.8%	60.3%
Education Participation Score	69.1	77.4	N/A
Continuing Education Tax Credits as Share of Total Tax Filings	11.3%	17.1%	10.8%
Idle Youth (Not Working or Enrolled)	1.0%	0.9%	0.0%
Preschool Enrollment	57.0%	43.2%	40.3%

Table 0.2: County Education comparison (US News and World Report, 2020)

Economy Score	83.2	56.3	N/A
Employment Score	84.6	58.1	N/A
Average Weekly Wage	$1,092	$741	$664
Labor Force Participation	71.8%	60.8%	55.5%
Unemployment Rate	2.8%	2.8%	2.6%
Income Score	92.1	56.9	N/A
Households Receiving Public Assistance Income	0.7%	1.2%	0.6%
Median Household Income	$84,915	$49,910	$46,295
Medical Debt in Collections	14%	14%	N/A
Poverty Rate	5.6%	21.6%	12.6%
Opportunity Score	56.8	49.5	N/A
Business Growth Rate	1.1%	9.2%	4.8%
Job Diversity Index Score	0.74	0.61	0.59
Jobs Within a 45-Minute Commute	124,370	14,671	1,379

Table 0.3: Employment Comparison (US News and World Report, 2020)

Food & Nutrition Score	46.7	26.3	N/A
Food Availability Score	40.2	20.8	N/A
Food Environment Index Score	9.79	5.10	1.40
Local Food Outlets	2.1/100k	5.3/100k	0.0/100k
Population Without Access to Large Grocery Store	21.8%	52.1%	93.7%
Nutrition Score	57.1	43.8	N/A
Diabetes Prevalence	7.1%	6.6%	7.8%
Obesity Prevalence	26.9%	26.4%	34.8%
Share of At-Home Food Expenditures on Fruit/Veg	12.1%	11.2%	12.0%

Table 0.4: Food and Nutrition comparison (US News and World Report, 2020)

Housing Score	60.9	34.8	N/A
Housing Affordability Score	53.7	37.5	N/A
Change in Housing Value	15.0%	11.4%	23.0%
Eviction Rate	1.7%	0.5%	0.4%
Households Spending at Least 30% of Income on Housing	23.6%	38.2%	23.4%
Work Hours Needed to Pay for Affordable Housing	38.0	48.0	36.0
Housing Capacity Score	53.3	32.1	N/A
Affordable Housing Shortfall	-67.9	-84.7	-58.8
Overcrowded Households	1.3%	3.0%	2.3%
Housing Quality Score	91.8	75.3	N/A
Households With Incomplete Plumbing Facilities	0.2%	0.4%	0.4%
Vacant Houses	0.9%	3.7%	3.5%

Table 0.5: Housing comparison (US News and World Report, 2020)

Environment Score	56.1	60.6	N/A
Air and Water Score	69	76.1	N/A
Airborne Cancer Risk	31.61	26.39	24.63
Air-Quality Hazard	0.45	0.37	0.35
Unsafe Drinking Water	0.0%	0.0%	1.0%
Natural Environment Score	30.1	39.2	N/A
Area With Tree Canopy	10.6%	13.5%	4.0%
Natural Amenities Index Score	-1.69	-0.11	-0.88
Population Within 0.5 Mile of a Park	48.4%	47.3%	35.5%
Natural Hazards Score	69.1	64.1	N/A
Extreme Heat Days per Year	12.0 days	14.7 days	13.3 days
Households in Flood Hazard Zone	1.5%	3.9%	16.4%
Toxic Release Index Score	203,404.67	360.34	0.00

Table 0.6: Environment and amenities comparison (US News and World Report, 2020)