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Food & Health in Wapello County, Iowa
TECHNICAL ADDENDUM

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Ottumwa Regional LEGACY FOUNDATION
Connecting Opportunity To Transformation

LIVE UNITED
United Way
United Way of Wapello County

CONTEXT

Mari Gallagher Research and Consulting Group (MG) conducted a block-level study for the Legacy Foundation and a wide range of community leaders on food access and health outcomes in Wapello County, Iowa. This included analyzing every store across the County and a 20-mile buffer around it that sells groceries. We also analyzed "major player fast food" restaurants within Wapello. The goal of the study was to assess how the food environment contributes to the wellbeing of the Wapello population. We used the analysis to inform solutions that can measurably improve quality and length of life, healthy food access and choice, and increased economic activity through the food system. We were especially interested in vulnerable populations and new ways to serve them. This included investigating if the food environment has an impact on the academic performance of schoolchildren.

DATA USE AGREEMENT

As part of the study, and for that exclusive purpose, MG entered into a HIPPA-compliant data sharing agreement with River Hills Community Health Center as well as a data sharing agreement with Ottumwa Community Schools. State and federal laws governing school data allow limited disclosure for research that aims to improve the local community, school system, and/or student body if there is an appropriate data use agreement between the data provider and the researcher that protects individual identify and confidentiality and if the nature of the research provides a worthy public benefit pursuit. Some school districts adopt their own additional written data policies. Ottumwa Community School District has its own data policies, described in Student Records Access Code No 506.1 (last reviewed and revised 6/13/05 by Ottumwa school officials and again reviewed 6/14/10). The data sharing agreement between MG and Ottumwa Community Schools reflected these provisions, and MG has operated in complete compliance with them, as well as with the River Hills agreement.

KEY TERMINOLOGY AND CONSIDERATIONS

Here we summarize key findings and their implications. First, a few key definitions: ***fringe*** and ***mainstream***. These are terms developed by MG in 2007 to code food stores in a given community or region. Fringe food retailers primarily sell food that is fast, readymade, boxed, canned or processed, and which is generally high in salt, fat and sugar, with limited, if any, nutritional value. Fringe food stores also typically specialize in “convenience” items such as candy, chips, lottery tickets, alcohol, and tobacco.

By contrast, mainstream (or healthy) food stores offer a variety of foods that support a nutritious diet on a regular basis. The data analysis included reviewing stores participating in the Supplemental Nutrition Assistance Program (SNAP, formerly called the Food Stamp Program) throughout Wapello and a 20-mile ***buffer zone*** around it and coding these retailers as either mainstream or fringe. Why do we include food stores outside the county border? Because those who live or work on the edge of Wapello, for example, might cross the official county line to buy groceries. So the data need to include, not just the food stores in the county, but also those in the larger buffer zone. There is not a perfect distance to a grocery

store or a perfect number of grocery stores that would apply to all communities. We must identify and analyze block-by-block patterns across the study area, including potential impacts from borderline food stores, to determine ideal distances and any community shortages.

There are a number of factors that can influence an individual's selection of a fringe or mainstream food store (e.g. household income, food cost, cultural preferences, etc.). We test if an individual's proximity to (or distance from) one type of store or the other is predictive of the type of store where he or she will predominantly shop. As a result, our study in Wapello focuses on distances from every populated block in the County to the nearest fringe and mainstream food vendors while accounting for additional factors including but not limited to household income, vehicle access status, and racial/ethnic composition.

Census ***block groups*** are geographical units used by the United States Census Bureau. The block group is between the Census tract and the Census block in terms of size. It is the smallest geographical unit for which the bureau publishes sample data, i.e. data that is only collected from a fraction of all households. The block-group-level characteristics utilized for this study were median household income, racial and ethnic composition, proportion of households headed by females and containing children under age 18, proportion of individuals over age 25 possessing at least a high school diploma, and the proportion of households without access to an automobile.

Finally, before we introduce our findings, it is important to note that our research provides information on the existence and strength of relationships between examined factors, but we cannot call the relationships between the factors causal. Nonetheless, the reported results are statistically significant and strong in magnitude, meaning that they are meaningful and did not happen by chance. They provide a blueprint for Wapello County leaders to take strategic action and measure results moving forward.

RESEARCH METHODOLOGY: RIVER HILLS COMMUNITY HEALTH CENTER DATA

The relationships between (1) access to fringe and mainstream food retailers and (2) health outcomes were analyzed. The data analysis included reviewing stores participating in the Supplemental Nutrition Assistance Program (SNAP, formerly called the Food Stamp Program) and coding them as either mainstream or fringe.

The analysis used Geographic Information System (GIS) software (QGIS v 2.4) and statistical software (Stata v 12). The GIS software was used to geocode each patient's street address and then to determine each individual's distance from the closest mainstream and SNAP fringe retail establishments selling at least some type of food. The statistical software was then used to analyze the relationship between food access and health metrics. The analysis used standard errors clustered by block-group to account for and remedy the fact that, although the individual was the unit of observation, a set of block-level demographic controls was included as well, and these did not vary across individuals within the same block-group. Individual patient characteristics were also utilized.

For health metrics, a regression analysis of the height, weight, body-mass index (BMI), and diabetes diagnosis for 6,500 Wapello County clients of the River Hills Community Health Center was performed. Individual-level characteristics included in the analysis, in addition to the distances to the nearest mainstream and fringe retailers, were age, race, gender, and ability to speak English. The block-group-level characteristics included were median household income, racial and ethnic composition, proportion of households headed by females and containing children under age 18, proportion of individuals over age 25 possessing at least a high school diploma, and the proportion of households without access to an automobile.

FINDINGS FROM RIVER HILLS COMMUNITY HEALTH CENTER DATA

1. **Health-related outcomes: height, weight, and diabetes**

   The relationships between (1) access to fringe and mainstream food retailers and (2) health outcomes were analyzed. We found statistically significant associations between distances to fringe and mainstream retailers and children's height, adult weight, body mass index (BMI), and adult diabetes.

2. **Children's height: distance from fringe food retailers linked to higher average height**

   Among children age 3 to 18, height was positively associated with distance from fringe food retailers. This relationship was "statistically significant" at the 10% level (p=0.07), which means that we can be confident that similar results would emerge if we performed the same analysis using other samples of individuals drawn from the same population. In other words, the finding is not likely a consequence of random noise in the data.

   Perhaps even more importantly, though, this relationship to height was also large in magnitude: every additional mile of distance from a fringe retailer was associated with an additional 0.28 inches in height. For two otherwise-identical children, the child living one standard deviation (1.28 miles) farther from a fringe retailer than the other child would be 0.35 inches taller than that other child.

   What are the implications?

   Height is an important predictor of a child's cognitive achievement and adult income, and is strongly and positively related to the mother's own education. A difference in height of 0.35 inches is roughly the difference we would expect between children of mothers with only a high school education and those with at least a college education in a developed economy.

   For adults (over age 18), however, there was no relationship between proximity to mainstream and fringe food retailers and height.

   There was also no relationship for either children or adults between distance to a

mainstream grocer and height.

3. **Adult weight: distance from mainstream food retailers linked to higher weight and BMI**

   The relationship between weight and mainstream food retailer distance for adults was statistically significant (p=0.08) and large in magnitude: a one standard deviation increase in distance from the nearest mainstream retailer (2.36 miles) was associated with a weight increase of 1.51 pounds. There was no relationship between weight and distance to the nearest fringe food retailer for adults. Additionally, there was no relationship between weight and either distance to mainstream or fringe retailers for children 3 to 18.

   Height and weight can be combined in a body-mass index (BMI=weight in pounds /[(height in inches)^2 x 703]). For adults, a BMI 18.5–24.9 is considered normal. In our regression analysis, distance to mainstream food retailers was a highly statistically significant predictor (p=0.01) of BMI for adults but not for children. For adults, a one standard deviation increase in distance from the nearest mainstream retailer (2.36 miles) was associated with an increase in BMI of 0.19 units. Distance to fringe retailers was not associated with BMI for either adults or children

4. **Adult diabetes: occurrence increases with distance from mainstream food retailers**

   The final health metric examined was whether an individual had been diagnosed with diabetes. There was a highly statistically significant (p=0.002) relationship for adults but not for children between this important diet-related measure and distance from a mainstream grocer. An additional standard deviation in distance to a mainstream food retailer (2.36 miles) was associated with an increase in the probability of a diabetes diagnosis of 0.5 percentage points. Since the probability of a diabetes diagnosis in the sample was 5.7 percent, a one standard deviation increase in distance from a mainstream grocer raised the risk of diabetes by 8.8% – for comparison, smoking raises the risk of diabetes by 30-40%, so an additional 2.36 miles distance from a mainstream food retailer is associated with an increase in diabetes equal to 25% of the impact of smoking. At about 5 miles, that would be 50%. At 10 miles, it would be an equal effect.

RESEARCH METHODOLOGY: OTTUMWA COMMUNITY SCHOOL DISTRICT DATA

In addition to examining health outcomes related to food access in Wapello County, we used a similar analytical approach to determine whether food access was associated with the academic performance of local schoolchildren. The data analysis included reviewing stores participating in the Supplemental Nutrition Assistance Program (SNAP, formerly called the Food Stamp Program) and coding them as either mainstream or fringe. The relationships between Ottumwa Community Schools' 4,300 K-12 students' (1) access to fringe and mainstream food retailers and (2) educational metrics, based on standardized test scores and grade point averages (GPA) were analyzed.

The analysis used Geographic Information System (GIS) software (QGIS v 2.4) and statistical software (Stata v 12). The GIS software was used to geocode each student's street address and then to determine each individual's distance from the closest mainstream and SNAP

fringe retail establishments selling at least some type of food. The statistical software was then used to analyze the relationship between food access and educational metrics. The analysis used standard errors clustered by block-group to account for and remedy the fact that, although the individual was the unit of observation, a set of block-level demographic controls was included as well, and these did not vary across individuals within the same block-group. Individual student characteristics were also utilized.

A regression analysis of achievement test scores and grade point averages (GPA) for 4,300 K-12 students in the Ottumwa Community Schools was performed. Individual-level characteristics included in the analysis, in addition to the distances to the closest mainstream and fringe retailers, were age, race, gender, ability to speak English, grade, and if the student receives a free or subsidized school lunch, which is a proxy for above or below low-income thresholds. The block-group-level characteristics included were median household income, racial and ethnic composition, proportion of households headed by females and containing children under age 18, proportion of individuals over age 25 possessing at least a high school diploma, and the proportion of households without access to an automobile. The student achievement scores were converted to percentiles (0-100) and averaged across all of the tests taken by the student. The student's middle and high school letter grades were converted to a numeric scale (0-4).

Please note that the findings are only applicable to Ottumwa Community School students. Those students living in Wapello County, but attending a school from another school district, were not included in the evaluation. Their scores likely have a similar relationship to the food environment, but with out analyzing the data, we cannot yet make that conclusion.

FINDINGS FROM OTTUMWA COMMUNITY SCHOOL DISTRICT DATA

5. The food environment and school performance

The achievement test score composite was strongly associated with both distance to mainstream and distance to fringe food retailers, and both of these relationships were highly statistically significant ($p<0.01$). Significance here means that we can be confident that similar results would emerge if we repeated the same analysis for prior years using other samples of Ottumwa Community School District students drawn from the same population. In other words, the finding is not likely a consequence of random noise in the data. A standard deviation in additional distance to a fringe retailer (0.78 miles) was associated with an additional 1.7 percentage points on the achievement tests, while a standard deviation in additional distance to a mainstream retailer (1.14 miles) was associated with an achievement test score that was 1.8 percentage points lower. For comparison, residing in a block-group with a median household income that was one standard deviation ($16,676) higher was associated with only an additional 1.36 percentage points ($p=0.02$).

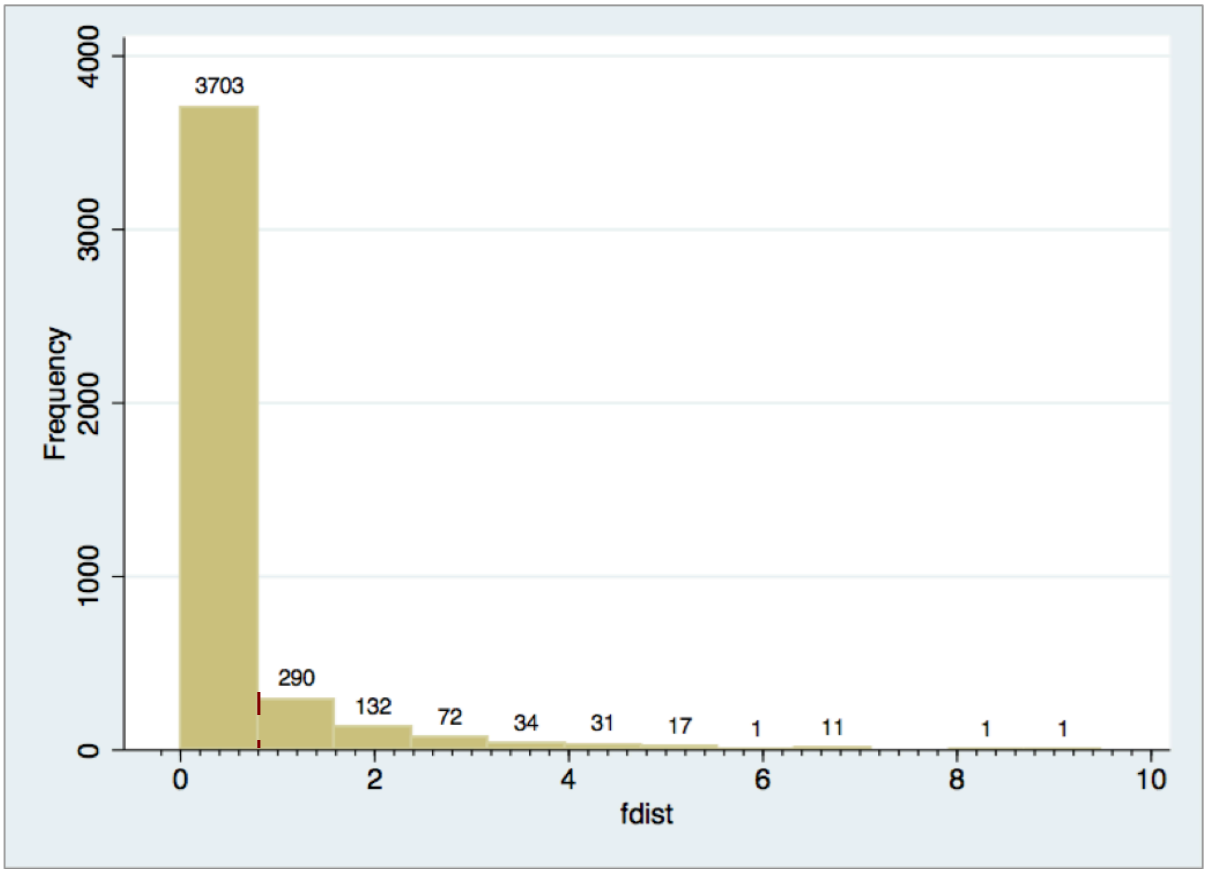
Here we illustrate the meaning of each of these findings:

6. <u>Living farther from stores specializing in junk food is associated with better performance of schoolchildren.</u>

Controlling for other contributing factors, students living just slightly more than three quarters of a mile from the closest fringe retailer (meaning living at least that far from stores primarily selling junk food) performed better on their composite academic scores by an additional 1.7 percentage points or more. As this distance increases, academic performance increases, and, for many students, the effect noticeably adds up.

Distances are calculated from each student's home address to the closest fringe location, shown in the graph below. The height of the frequency bar reflects the number of students. The axis entitled "fdist" shows the distance to the closest fringe store in increments of one standard deviation. The red dashed vertical line shows the marker after which the first standard deviation ends. The second bar to the right of the red line labeled "290" is the second standard deviation grouping.

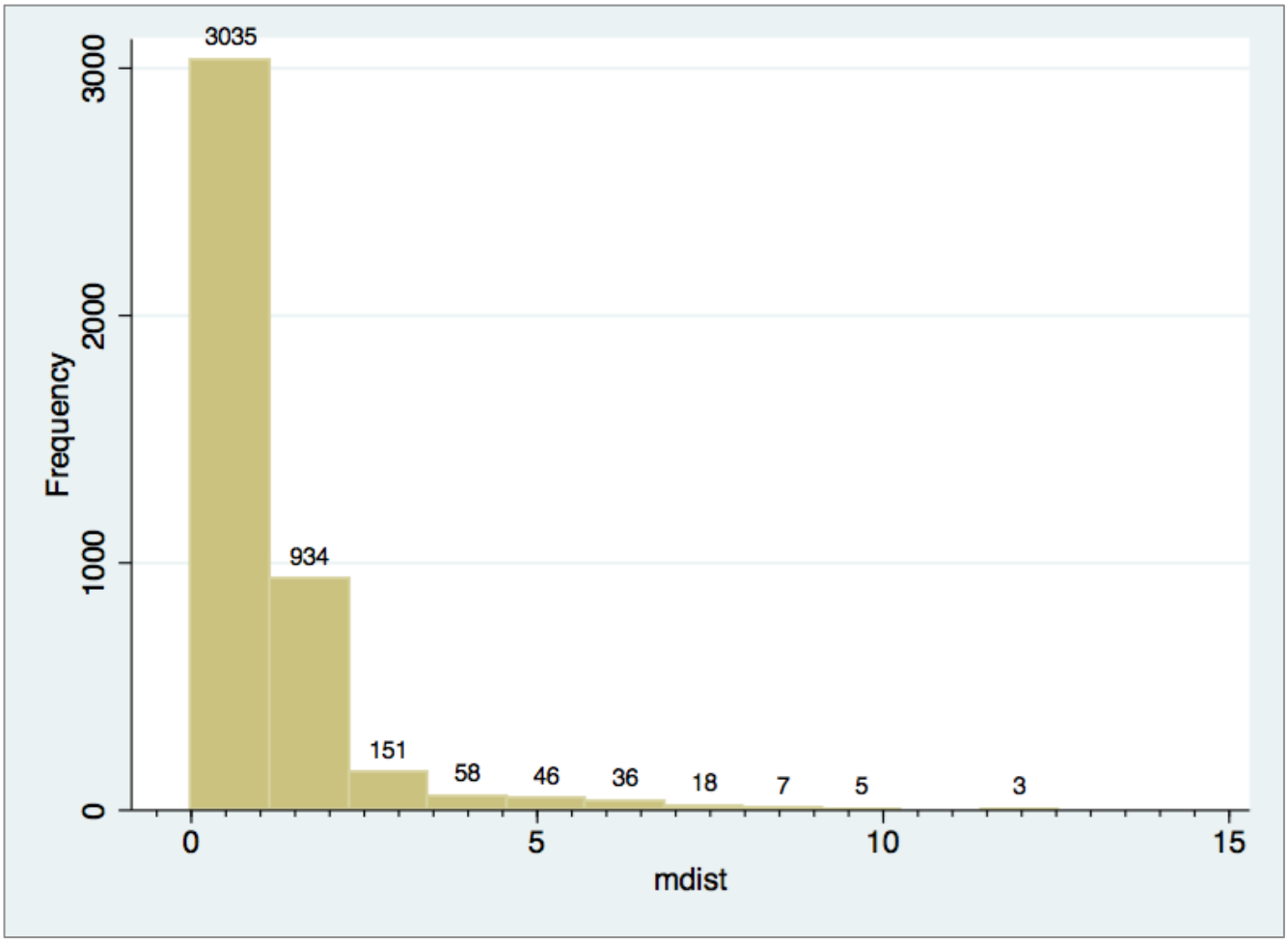
In the first bar, 3,703 students are within one standard deviation of a fringe retailer. At the point on the "fdist" axis marked "0", a student would be located at the exact same location as the fringe store (because there is zero distance to the fringe store). At that point, there is no relationship between the geographic location of the fringe store and student composite performance scores. But a significant relationship with scores begins as distance increases past 0. When it increases to 0.78 miles away (one standard deviation), a student's average test score is 1.7 percentage points higher than that of a student who lives exactly at the fringe location. A student 2 standard deviations from the closest fringe store has a test score 3.4 percentage points higher than a student who lives exactly at the fringe location, and 1.7 percentage points higher than a student who lives 0.78 miles from the closest fringe store.



The farther we move to the right of this graph, the more these percentage points add up. Consider that the 17 students represented at the 5th standard deviation mark, on average, have scores nearly 12 percentage points higher and that the 11 students at the 7th standard deviation, on average, have scores over 15 percentage points higher than they would if their scores were zero. This is not to say that all students should live at far as possible from fringe stores, but that this aspect of the food environment clearly has a relationship with academic performance. In these types of studies, we can never call the relationships causal, but the results are strong enough to suggest that they are meaningful and did not happen by chance.

7. **Living farther from stores specializing in healthy food is associated with worse performance of schoolchildren.**

Controlling for other contributing factors, students living farther from mainstream food store offering healthy groceries performed worse academically. The standard deviation is 1.14 miles of distance to the mainstream store. For every standard deviation of that distance, academic performance drops an additional 1.8 percentage points. The farther the mainstream store, the more these percentage points add up. For example, the 18 students living 7 standard deviations away from mainstream grocery options have an average performance of 12.6 points below students with zero distance, after controlling for other key factors. Please see the graph below for more details.



8. **The food environment matters more than the median income level of the block group in which the student lives.**

   There are many reasons why students do well or poorly in school. Natural talents, motivation, family stability, household income, and many other factors can contribute. In this study, we are seeking to isolate and examine the contribution of the food environment. Interestingly, for comparison purposes, when we analyze the relationship between academic performance and – not the food environment this time – but, instead, median household income in the block group, we find that it also has an effect: each standard deviation increment to income was associated with an additional 1.36 percentage point boost in the average score. We would expect performance to correlate significantly with income. The surprising finding is that the Wapello County food environment not only also contributes, but also contributes *more* in terms of the total percentage points at each standard deviation. It is certainly easier to change the school district's food environment than family incomes across entire block groups. That the evidence suggests the food environment would matter this much is encouraging because it is a program and policy challenge that many community actors can help address.

Additional analysis

In order to account for the possibility that the relationship between food access and a particular health or educational measure may be non-linear (e.g. the relationship per unit of distance is stronger at longer distances than a shorter distances), we experimented with other functional forms in our regression analysis other than the linear form we have reported to this point. Such changes did in fact produce some differences to the results (generally resulting in more precise estimates of these relationships). However, in no cases did they reverse the sign of the effects already reported.

For example, in the analysis of adult BMI, we converted the fringe and mainstream distances to natural logarithms and used these as regressors instead of the actual values. The new relationships for fringe and mainstream distance were statistically significant ($p=0.05$), similar to each other in absolute magnitude (≈ 0.30), and opposite in sign (fringe -, mainstream +). This indicates that a 1% rise in fringe distance was associated with a decline of 0.03 BMI units (or a decline of 1.5 BMI units for a 50% rise in fringe distance). A 1% rise in mainstream distance was associated with a rise of 0.03 BMI units (or a rise of 1.5 BMI units for a 50% rise in mainstream distance). Recall that a given percentage change is a larger absolute magnitude at higher absolute magnitudes (a 50% rise from a value of 2 brings us one unit higher, to 3; a 50% rise from a value of 10 brings us five units higher, to 15). These non-linear results suggest that the effect of changes in food access are greater at shorter than at longer distances. For the sake of simplicity in interpreting the results, we have otherwise reported only the linear version of our analysis.

Additionally, we analyzed students' grades to determine whether they were similar to test scores with regard to their association with students' proximity to/ distance from fringe and mainstream retailers.

The student's middle and high school letter grades were converted to a numeric scale (0-4). GPA in middle school was again strongly associated with both distance to mainstream and distance to fringe food retailers, and both of these relationships were highly statistically significant ($p<0.01$). A standard deviation in additional distance to a fringe retailer (0.79 miles) was associated with an increment of 0.17 GPA units, while a standard deviation in additional distance to a mainstream retailer (1.14 miles) was associated with a GPA that was 0.11 units lower. For comparison, residing in a block-group with a median household income that was one standard deviation ($16,676) higher was associated with only an additional 0.06 GPA units ($p<0.01$).

GPA in high school followed the same pattern: greater distance from fringe retailers was associated with a higher GPA, while greater distance from mainstream retailers was associated with a lower GPA. These relationship were again highly statistically significant ($p<0.01$), though the magnitude of the fringe effect was 20% lower (0.164 GPA units per mile of distance, as opposed to 0.209 GPA units per mile of distance in the middle school analysis) and the magnitude of the mainstream effect was 8% higher (0.103 GPA units per mile of distance, as opposed to 0.096 GPA units per mile of distance in the middle school analysis). The GPA change associated with either a one standard deviation rise in fringe distance (+0.13 GPA units) or in mainstream distance (-0.12 GPA units) remained considerably larger than the GPA change associated with a one standard deviation rise in block-group median household income (+0.09 GPA units, $p<0.01$).