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Rural Adolescent Health: Issues, Behaviors and Self-Reported Awareness

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Abstract

Purpose: The purpose of the study was to examine the health status of rural adolescents and young adults through a comprehensive review of detailed health information, behavior and health awareness. The disparity in health awareness between rural and non-rural residents compared and evaluated.

Methods: Rural-Urban Commuting Area (RUCA) codes were combined with respondent-level data from the Longitudinal Survey of Adolescent to Adult Health (Add Health) to classify individuals as rural/non-rural residents. Health characteristics and perceived health awareness was tested for statistically significant differences. Differences in weight perception accuracy was compared for systematic differences controlling for self-selection into rural areas using a two-stage selection model.

Findings: Analysis revealed that rural residents have a higher incidence of major health conditions including epilepsy, high cholesterol, high blood pressure and diabetes. Additionally, they have a higher prevalence of unhealthy behaviors including drinking and drug use. Rural residents are less likely to be insured, but more likely to be overweight or obese. While rural adolescents are more likely to mis-classify their body weight, this misclassification is a result of the higher incidence of overweight rather than the residential location.

Conclusion: The higher prevalence of chronic conditions combined with the lower income and education levels suggests the rural environment is a unique and potentially challenging context for adolescent health. Improving rural adolescent health will require innovative solutions appropriate for rural environments and changes in individual health literacy. Solutions must be multisectoral, engaging education, economic development, and other community perspectives to establish key drivers for health equity.

Purpose

Since 2000, the rural population has grown less than urban and suburban, resulting a in smaller share of Americans living in rural counties (Pew Research Center 2018). A lower population base has led to a lack of health facilities. Marginalized rural populations are particularly vulnerable to underrepresentation and policy neglect [1]. The difficulty in accessing quality health care combined with the rising cost of health care has put rural communities at risk for poor health outcomes [2]. A lack of information on the health status and risks of adolescent youth in rural areas undermines policymakers' ability to justify competitive budget expenditures for preventive care in rural areas. It is crucial to understand who they are and what contributes to health, chronic disease and conditions, to address the healthcare needs of rural communities.

Despite the difficulties faced by rural residents and evidence of disparate health, recent literature has focused primarily on substance (drug and alcohol) abuse, fertility, or mental health issues. While many comprehensive health assessments of rural adolescents and young adults in Africa, Asian, and Latin American have been published over recent decades, less attention has been directed to the general health of young people in the United States. This study will supplement existing literature by providing an assessment of adolescent/young adult health in the US. This study uses a unique dataset with comprehensive health, clinical and biological outcomes to focus on three dimensions of adolescent health-chronic disease, health behavior and health self-awareness-in order to provide an understanding of the health issues faced by rural adolescents and possible avenues to health solutions.

High-risk behavior is a significant health risk faced by young adults. A rural environment presents developmental risk behaviors that may increase the probabilities for adverse health outcomes in adolescence. Rural adolescents, particularly among poor and minority youth, are susceptible to significant risk behaviors and health concerns [1]. Studies have found that alcohol and drug use, pregnancy, and sexually transmitted disease rates are higher among rural adolescents [3,4]. Rural areas have higher rates of alcohol, tobacco, and methamphetamine use, while prescription drug abuse and heroin use has grown in towns of every size. Rural youth are particularly vulnerable to the availability of marijuana because of the ability to produce the illegal drugs in rural regions and greater difficulty providing treatment [5]. Drug and alcohol abuse is difficult to combat in rural areas due to limited resources for prevention, treatment, and recovery [6]. Factors contributing to drug abuse in rural America include low educational attainment, poverty, unemployment, high-risk behaviors, and isolation [6]. Lack of employment opportunities, transportation, educational opportunities, health services, and health insurance are associated with living in rural areas and have been shown to increase rural adolescents' health vulnerability [7]. Additionally, rural adolescents with drug and alcohol abuse problems face the challenges of accessing adequate treatment and recovery [8].

Rates of both teen and unintended teen pregnancy are over 60 percent higher in rural areas than urban. Disparities in teen birth rates for those in rural counties are associated with reduced access to health services, lack of health insurance, poverty, and the proportion of female-headed households [9]. Such high rates are also directly associated with sexual activity and contraceptive use [10]. National data indicate that, compared to urban teens, rural teen females are

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more likely to report ever having had sex, yet less likely to report the use of contraception at first sex [11]. More troubling is that young adults represent only 25 percent of the sexually experienced population but 50 percent of all new sexually transmitted diseases [12]. While educating adolescents on sexual health topics has been shown to curb unplanned pregnancies and decrease the incidence of sexually transmitted diseases, these sexual education programs are costly to implement and politically controversial [13].

One of the most frequently cited indicators of rural health is the disproportionately high rates of overweight and obesity rates. Residence in rural areas is associated with higher prevalence or increased odds of obesity compared to those living in urban areas. Rural adolescents have 26 percent greater odds of obesity, compared to urban adolescents. While most studies focus on those individual factors such as poverty rates, low education levels, and lifestyle differences that may contribute to obesity, some examine associations with environmental characteristics such as food environment [1], physical changes, and social dynamics [14]. It is generally accepted that longer exposure to certain physical and social environments may contribute to differences in urban and rural obesity, but the mechanisms through which environmental aspects promote obesity warrants further study [15].

Young adults, like most residents of rural communities, often struggle with access to care. This struggle is mainly due to unique rural challenges like few local doctors, poverty, and remote locations [16]. Rural areas suffer from a lack of physicians, specialists, nurses, and other healthcare practitioners, making it more difficult and cumbersome to obtain adequate preventative care [13]. Research estimates that an effective and efficient physician-to-population ratio is 1:1200, but the ratio is only 1:1910 in rural areas compared to 1:1300 in urban areas. National Rural Health Association reports that there are nearly 10 times more specialists per 100,000 urban residents compared to rural communities [16]. The lack of local doctors and living in remote areas contributes to delay or avoid care because of the great distance needed to travel for care.

Mental health services are even more challenging to obtain. Rural youth are among one of the groups that have higher rates of suicide in comparison to their urban peers [16]. More than 85% of rural residents live in areas with shortages of mental health professionals [17]. This shortage of leaves 65% of rural residents to receive mental health services from their primary care physicians despite having a higher incidence of mental illness, depression, and other treatable mental/emotional conditions [18,19]. Subsequently, rural residents are more likely to use pharmacology than psychotherapy to treat mental health disorders [20]. While mental health falls outside the scope of this study, the author plans subsequent analyses focusing specifically on this sector.

This study proceeds with a discussion of the data and methodology utilized, including the identification strategy and health outcomes selected, followed by a detailed outline of the primary significant differences between rural and non-rural youth and the most prevalent concerns among young adults in rural areas. Regression analysis attempts to explain some of these observed differences and most startling concerns. These ideas are then summarized with concluding remarks.

Methods

Identification: One primary explanation for variation in rural health outcomes research is the variable definition of rural. While the many definitions of the term rural seldom agree, the USDA Economic Research Service recommends that the choice of a rural definition be based on the purpose of the activity or the availability of information. This study utilizes the Rural-Urban Commuting Area (RUCA) codes which classify U.S. census tracts using measures of population density, urbanization, and daily commuting. RUCA codes are readily available in the data set used for this analysis. The most recent RUCA codes are based on data from the 2010 decennial census and the 2006-10 American Community Survey (ACS).

The Office of Management and Budget (OMB) uses RUCA codes to identify counties as metropolitan, micropolitan or neither. A metropolitan area contains a core urban area of 50,000 or more population while a micropolitan area contains an urban core of at least 10,000, but less than 50,000. All counties not part of a Metropolitan Statistical Area (MSA) are considered rural. Micropolitan counties are considered non-metropolitan or rural along with all counties not classified as metro or micro. After the 2010 Census, the non-metro counties contained 46.2 million people-15 percent of the US population and 72 percent of the land area of the country. This included all census tracts inside metropolitan counties with the codes 4-10 to be rural. Based on this assessment and review, this study classified respondents in areas with RUCA codes of 4-10 as rural aligning with OMB recommendations.

Data: Analysis utilizes data from the National Longitudinal Study of Adolescent to Adult Health (Add Health)-a longitudinal study of adolescents in grades 7-12 during the 1994-95 school year followed into young adulthood with four in-home interviews. Add Health combines longitudinal survey data on respondents' social, economic, psychological and physical well-being with contextual data on the family, neighborhood, community, school, friendships, peer groups, romantic relationships and biological data, providing unique opportunities to study how social environments and behaviors in adolescence link to health and achievement outcomes in young adulthood.

Data in this analysis is drawn specifically from Wave III conducted in August 2001-April 2002. Wave III, conducted when respondents were between 18 and 26 years old, focuses on how adolescent experiences and behaviors are relate decisions, behavior

Table 1a:

BMI Value	CDC Category	Add Health Perception
<=18.49	Underweight	Underweight
18.50-24.99	Normal Weight	About the right weight
25.0-29.99	Overweight	Slightly Overweight
30.0+	Obese	Very Overweight

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Table 1: Covariate descriptive statistics.

	Non-Rural			Rural		
	12875			1183		
	N	Mean	Std Error	N	Mean	Std Error
Race/Ethnicity						
White	6556	64.5822	3.0101	790	75.5688	5.611
Black	2487	14.6194	2.0185	316	19.2103	5.1117
Hispanic	1028	5.5378	0.8731	11	0.7987	0.2826
Indian	415	2.9525	0.4436	45	3.0867	0.8599
Asian	1117	4.5415	0.9181	8	0.3829	0.2047
Other	1250	7.7666	1.1086	13	0.9526	0.3549
Age/Gender						
Age	9820	19.751	0.127978	948	19.8021	0.255906
Male	6764	48.8644	0.6768	646	51.4848	1.5323
Female	6099	51.1356	0.6768	537	48.5152	1.5323
School Enrollment						
Not Enrolled in School	7908	63.1946	1.5119	896	74.5069	2.2166
Enrolled in School	4941	36.8054	1.5119	287	25.4931	2.2166
Highest Grade Completed						
6	7	0.0441	0.0235			
7	10	0.1061	0.0437			
8	52	0.6961	0.1564	10	0.5262	0.2492
9	195	2.1295	0.2659	27	2.5964	0.58
10	412	4.2883	0.3771	70	6.4159	0.9813
11	823	6.553	0.4106	121	10.4783	1.4387
12	4108	32.2841	1.3947	507	41.8246	1.9295
13	1934	16.0101	0.9409	159	12.9007	1.2475
14	1951	14.3438	0.6021	141	11.6303	1.3514
15	1268	8.7915	0.6251	75	6.9965	1.304
16	1480	10.3058	0.9872	48	4.1176	1.0093
17	371	2.4449	0.283	17	1.3358	0.3812
18	123	0.992	0.153	3	0.3862	0.2271
19	69	0.5286	0.083	2	0.293	0.2754
20	49	0.377	0.082	2	0.335	0.2551
21	8	0.062	0.0301			
22	3	0.043	0.0302	1	0.1635	0.1676
Average Highest Grade Completed	12863	13.1308	0.090942	1183	12.5578	0.111956
Household Circumstance						
Household size	9581	4.32943	0.033446	910	4.217	0.071898
Lives with mother	8983	93.3223	0.4339	846	91.8895	1.0438
Lives with father	7440	78.596	1.1292	664	75.2789	1.6555
Income Parental/Earned/Household						
Parental Income	9707	$47,009	1.791871	911	$33,967	1.725714
Income from earnings	9708	$12,941	431.7947	816	$11,164	952.6318
Household income	3059	$62,142	2348.48	265	$37,641	2769.819
Current Health Insurance Situation						
You have no health insurance.	2915	24.1231	0.9158	333	28.721	1.9823
You are covered by your parents' insurance.	3413	27.3756	1.603	218	20.4388	2.2762
You are covered by your husband's or wife's insurance.	535	3.8294	0.3502	95	8.178	1.3951
You get insurance through work.	4196	30.8677	1.2746	335	27.6481	1.7675
You get insurance through a union.	77	0.5254	0.0908	5	0.5697	0.2953
You get insurance through school.	327	2.4399	0.3286	12	0.8619	0.2733
You are covered because you are active-duty military.	198	1.5208	0.1582	9	0.5705	0.3031
You buy private insurance yourself.	278	2.2642	0.251	34	3.3388	0.7702
You are on Medicaid.	745	6.17	0.6812	126	8.6948	1.2351
You are covered through the Indian Health Service.	26	0.2481	0.1708	2	0.0792	0.0805
You don't know what your health insurance coverage is.	72	0.6359	0.113	9	0.8992	0.3607
Months Covered by Health Insurance Last Year						
Months last year have health insurance	12806	8.76413	0.114088	1173	8.21798	0.220624
BMI Classification						
Underweight	359	2.8528	0.1741	29	2.4978	0.6216
Normal Weight	5418	43.0547	1.1497	440	37.8984	1.9113

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Overweight	3726	29.609	0.5067	312	26.8734	1.3118
Obese	3081	24.4835	1.0642	380	32.7304	2.0066
Weight Perception (Self-Reported)						
Very Underweight	155	1.1956	0.1478	11	0.7126	0.2949
Slightly Underweight	1437	11.8442	0.4066	113	8.9982	0.8284
Normal Weight	6135	47.9518	0.8577	549	45.6863	1.9268
Slightly Overweight	4294	33.151	0.6998	415	37.0928	2.0026
Very Overweight	822	5.8574	0.4139	93	7.5101	0.9772
Weight Action (Self-Reported)						
Lose Weight	4349	32.1654	0.6913	380	33.722	1.579
Gain Weight	2016	16.0536	0.6293	158	12.5693	1.3897
Stay the same weight	1976	15.2615	0.5407	147	12.9375	1.3546
Not trying to do anything	4500	36.5195	0.7521	496	40.7712	2.6214
General Health Status (Self-Reported)						
Excellent	4242	32.388	0.6393	379	31.1397	2.025
Very Good	5238	41.1549	0.6395	462	39.7833	1.8905
Good	2814	21.7971	0.6092	271	22.2716	2.0622
Fair	524	4.2773	0.2955	63	6.3396	0.9266
Poor	44	0.3827	0.0731	8	0.4658	0.255
Behavior						
Hours television watching weekly	12741	12.7835	0.266617	1170	13.992	0.805366
Times exercise in last week	12833	5.87526	0.103162	1181	5.94603	0.30212
Gets enough Sleep	193	73.6075	3.1331	952	80.5103	1.7397
Days drink in last 12 months	9835	2.93523	0.038049	834	2.58848	0.07968
Days smoke in last month	4027	24.8003	0.224249	479	25.5647	0.502792
Illegal Drugs						
Taken sedative last 5 years	12670	0.1139	0.005676	1162	0.10173	0.011782
Taken tranquilizers last 5 years	12676	0.09118	0.005118	1163	0.08818	0.016073
Taken stimulants last 5 years	12675	0.07965	0.004248	1166	0.0833	0.011478
Taken pain killers last 5 years	12661	0.20137	0.007233	1165	0.18703	0.0146
Taken steroids last 5 years	12680	0.0193	0.001919	1166	0.01495	0.004042
Used marijuana last 5 years	12657	0.47693	0.012005	1166	0.36284	0.023749
Used marijuana 1 last year	5702	0.71624	0.008777	429	0.69876	0.026699
Frequency used marijuana last 30 days	3975	11.8377	0.533064	296	9.8266	0.96387
Chronic Health Conditions						
Asthma	2168	16.907	0.563	163	15.0583	1.0631
Cancer/Leukemia	116	0.7617	0.1033	10	1.005	0.4273
Depression	1328	11.3926	0.4803	137	13.4567	1.4405
Diabetes	120	0.9076	0.1419	18	1.5876	0.4031
Epilepsy/Seizure Disorder	160	1.3949	0.1795	32	2.4436	0.5154
High Cholesterol	582	4.4489	0.289	38	3.2651	0.5594
High Blood Pressure	677	5.4189	0.3038	96	8.4615	0.9888
STD	12796	0.12535	0.008164	1174	0.09798	0.019206
Health Status						
Baroreflex Sensitivity (ms/mmHg)	11022	0.70035	0.059876	1039	0.45785	0.044319
Pulse Rate Recovery (beats/min)	11022	1.05952	0.055284	1039	0.82731	0.034677
SBP Recovery (mmHg)	11022	-0.61804	0.069721	1039	-0.94966	0.044025
High Sensitivity C-RCTV Protein (hsCRP)(MG/L)	9888	4.68294	0.119603	969	5.63744	0.352647
Epstein Barr Viral Capsid Antigen (EBV)(AU/ML)	9951	151.025	1.639873	973	150.133	3.466914
Count of Infectious/Inflammatory Diseases	11021	0.45999	0.010425	1039	0.44052	0.029067
Count of Subclinical Symptoms	11021	0.45529	0.010258	1039	0.46329	0.032034
Glucose (MG/DL)	9889	107.27	0.480135	960	109.333	1.282897
Hemoglobin A1c (%)	10149	5.57889	0.014988	989	5.65618	0.050861
Diabetes Joint Classification	11022	0.06205	0.004078	1039	0.07411	0.013395
Anti-Diabetic Medication Use	11022	0.01266	0.001505	1039	0.01749	0.005455
Triglycerides Decile	9636	5.58072	0.057281	936	5.91673	0.134905
Total Cholesterol Decile	9852	5.58067	0.053905	962	5.54253	0.140337
HDL Cholesterol Decile	9692	5.45514	0.057367	942	5.49539	0.155284
LDL Cholesterol Decile	9253	5.58159	0.053302	893	5.42939	0.159837
Total Number of Medications Currently Using	4145	1.86364	0.0309	429	1.95759	0.09849

Source: National longitudinal survey of adolescent to adult health, Wave III, restricted use file

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Table 2: Test of statistically significant rural, non-rural differences.

Diagnosed with High Cholesterol			
Effect	F Value	Pr > F	
Rural	3.12*	0.0799	
Parameter	High Cholesterol	Estimate	Std Error
Intercept	Not Diagnosed	3.2283***	0.099
Rural	Not Diagnosed	-0.1597*	0.0905
Diagnosed with High Blood Pressure			
Effect	F Value	Pr > F	
Rural	11.66***	0.0009	
Parameter	High Blood Pressure	Estimate	Std Error
Intercept	Not Diagnosed	2.6212***	0.0705
Rural	Not Diagnosed	0.24***	0.0703
Number of STD Diagnoses			
Source	Sum of Squares	Mean Square	F Value
Model	1293	1292.614	2.06
Error	8767058	627.114	
Effect	F Value	Pr > F	
Model	1.73	0.1905	
Intercept	113.05***	<.0001	
Rural	1.73	0.1905	
Baroreflex Sensitivity (ms/mmHg)			
Source	Sum of Squares	Mean Square	F Value
Model	91940	91940.03	14.02***
Error	79087053	6558.34	
Effect	F Value	Pr > F	
Model	10.54***	0.0015	
Intercept	241.58***	<.0001	
Rural	10.54***	0.0015	
Pulse Rate Recovery (beats/min)			
Source	Sum of Squares	Mean Square	F Value
Model	84299	84298.78	15.09***
Error	67348012	5584.88	
Effect	F Value	Pr > F	
Model	12.45***	0.0006	
Intercept	849.5***	<.0001	
Rural	12.45***	0.0006	
Systolic Blood Pressure Recovery (mmHg)			
Source	Sum of Squares	Mean Square	F Value
Model	171923	171923.2	19.53***
Error	1.06E+08	8804.6	
Effect	F Value	Pr > F	
Model	16.46***	<.0001	
Intercept	353.76***	<.0001	
Rural	16.46***	<.0001	
High Sensitivity C-RCTV Protein (hsCRP)(MG/L)			
Source	Sum of Squares	Mean Square	F Value
Model	1318239	1318239	12.27***
Error	1.17E+09	107410	
Effect	F Value	Pr > F	
Model	6.87***	0.0098	
Intercept	727.41***	<.0001	
Rural	6.87***	0.0098	
Epstein Barr Viral Capsid Antigen (EBV)(AU/ML)			
Source	Sum of Squares	Mean Square	F Value
Model	1156102	1156102	0.07
Error	1.72E+11	15717576	
Effect	F Value	Pr > F	
Model	0.05	0.8163	
Intercept	6086.19***	<.0001	
Rural	0.05	0.8163	
Count of Infectious/Inflammatory Diseases			
Source	Sum of Squares	Mean Square	F Value
Model	593	592.9066	0.83
Error	8600782	713.2843	
Effect	F Value	Pr > F	
Model	0.43	0.5154	
Intercept	808.51***	<.0001	
Rural	0.43	0.5154	
Count of Subclinical Symptoms			
Source	Sum of Squares	Mean Square	F Value
Model	100	100.1764	0.12
Error	10104300	837.9748	
Effect	F Value	Pr > F	
Model	0.06	0.8109	
Intercept	744.41***	<.0001	
Rural	0.06	0.8109	
Glucose (MG/DL)			
Source	Sum of Squares	Mean Square	F Value
Model	6112566	6112566	4**
Error	1.66E+10	1529982	
Effect	F Value	Pr > F	
Model	2.31	0.131	
Intercept	24898.9***	<.0001	
Rural	2.31	0.131	
Hemoglobin A1c (%)			
Source	Sum of Squares	Mean Square	F Value
Model	8851	8851.242	8.8***
Error	11205436	1006.235	
Effect	F Value	Pr > F	
Model	2.19	0.1416	
Intercept	43154.4***	<.0001	
Rural	2.19	0.1416	
Diabetes Joint Classification			
Source	Sum of Squares	Mean Square	F Value
Model	228	227.5605	2.49
Error	1101430	91.3368	
Effect	F Value	Pr > F	
Model	0.82	0.3681	
Intercept	86.56***	<.0001	
Rural	0.82	0.3681	
Anti-Diabetic Medication Use			
Source	Sum of Squares	Mean Square	F Value
Model	36.5	36.51253	1.83
Error	240789.2	19.96759	
Effect	Pr > F		
Model	0.73	0.3931	
Intercept	28.49***	<.0001	
Rural	0.73	0.3931	
Triglycerides Decile			
Source	Sum of Squares	Mean Square	F Value
Model	158263	158263	12.61***

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Error	1.33E+08	12552.3	
Effect	F Value	Pr > F	
Model	5.64**	0.019	
Intercept	5698.14***	<.0001	
Rural	5.64**	0.019	
Total Cholesterol Decile			
Source	Sum of Squares	Mean Square	F Value
Model	2094.6	2094.6	0.16
Error	1.38E+08	12800.42	
Effect	F Value	Pr > F	
Model	0.07	0.792	
Intercept	5041.99***	<.0001	
Rural	0.07	0.792	
HDL Cholesterol Decile			
Source	Sum of Squares	Mean Square	F Value
Model	2286.9	2286.95	0.18
Error	1.37E+08	12872.31	
Effect	F Value	Pr > F	
Model	0.06	0.8014	
Intercept	4022.53***	<.0001	
Rural	0.06	0.8014	
LDL Cholesterol Decile			
Source	Sum of Squares	Mean Square	F Value
Model	30750.2	30750.18	2.41
Error	1.29E+08	12743.35	
Effect	F Value	Pr > F	
Model	0.85	0.357	
Intercept	4108.71***	<.0001	
Rural	0.85	0.357	
Total Number of Medications			
Source	Sum of Squares	Mean Square	F Value
Model	5775	5775.357	1.75
Error	15129349	3309.131	
Effect	F Value	Pr > F	
Model	0.76	0.3837	
Intercept	1469.12***	<.0001	
Rural	0.76	0.3837	

and health outcomes in the transition to adulthood. Biological specimens, urine and saliva samples, were obtained from a subset of Wave III respondents for tests Chlamydia Trachomatis (CT), Neisseria gonorrhoeae (GC), and other experimental STI testing. An Oral Mucosal Transudate (OMT) specimen allowed for Human Immunodeficiency Virus Type-1 (HIV-1) testing along with other curable STDs. Saliva samples enabled DNA extraction, purification and subsequent genotyping of respondents.

In addition to biological and health outcomes data, Wave III contains data specific to the late adolescent, young adulthood life stage on parent-child and sibling relations, contact with friends from high school, the role of mentors and mentoring relationships, personal income, wealth and debt, civic and political participation, children and parenting, involvement with the criminal justice system, and religion and spirituality. Wave III also has extensive information on health and health related behavior including diet, physical activity, access and use of health services, sexual behavior, contraception, sexually transmitted infections, pregnancy and childbearing, suicidal intentions and thoughts, mental health and depression, drug and alcohol use and abuse, injury, delinquency, and violence in addition to physical measurements of height and weight. Mean values for biological, demographic, social and behavioral characteristics are given in (Table 1).

Covariates-Health Related Behaviors: A variety of behavioral patterns are included in the Add Health survey. As with all surveys, patterns of omission, valid skip, non-response and refusal can impact the robustness of response data. In order to capture behavioral impacts on health and provide robust estimates, exercise frequency, sleep sufficiency, television watching, cigarette smoking, alcohol consumption and marijuana and illegal drug use are examined. Illegal drugs include sedatives, tranquilizers, stimulants, pain killers and steroids used by respondents anytime during the five years prior to their interview. Additionally, this study examines frequency of marijuana use in the last 12 months and last 4 weeks.

Alcohol consumption is measured as the number of days the respondent drank in the last 12 months, while smoking is measured as the number of days in the last month the respondents smoked. Binary indicators are added for having health insurance and receiving enough sleep, while variant terms measure the frequency of exercise and hours of television watching in an average week.

Covariates-Health Issues/Indicators: Three measure of cardiovascular fitness are provided-Systolic Blood Pressure (SBP) Recovery, Pulse Rate Recovery (PRR) and Baroreflex Recover. First, SBP recovery after exercise represents an important index of cardiovascular and autonomic nervous system response to physical stress and has been shown to be a clinical tool applied toward diagnosing cardiovascular abnormalities. Second, PRR is a pulse measurement taken immediately following intense exercise. PRR is used in some fitness tests to evaluate the heart's ability to recover from exercise and is used to evaluate the heart's ability to recover from exercise. Finally, the baroreflex acts as an effective buffer of short-term blood pressure fluctuations that accompany daily life. Studies suggest that a diminished baroreflex recovery is an independent risk factor for sudden death after myocardial infarction. In hypertensive humans and animals, the baroreflex control of heart rate is diminished.

In addition to SBP Recovery, PRR and Baroreflex recovery, thirteen additional clinical measures are reported for each respondent. These measures indicate the existence, persistence or maintenance of health issues. 1) High Sensitivity C-reactive Protein (hsCRP) is a protein that increases in the blood with inflammation and infection as well as following a heart attack, surgery, or trauma. Studies have suggested that a persistent low level of inflammation is often associated with Cardiovascular Disease (CVD). The hs-CRP test accurately measures low levels of CRP to identify low but persistent levels of inflammation and helps predict a person's risk of developing CVD.

The 2) Epstein Barr Viral Capsid Antigen (EBV) indicates that a person has or has had the Epstein Barr Virus. EBV is a member of the herpes virus family and one of the most common viruses to infect people around the world. According to the Centers for Disease Control and Prevention (CDC) most people will contract EBV at some point. In adolescents and adults, it causes an illness called infectious mononucleosis, or mono, in about 35 to 50 percent of cases. Also known as "the kissing disease," EBV is usually spread through saliva

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and rarely through blood or other bodily fluids.

Additionally, 3) Glucose level, 4) Hemoglobin A1c level, 5) Triglycerides Decile, 6) Total Cholesterol Decile, 7) HDL Cholesterol Decile and 8) LDL Cholesterol Decile are provided in addition to four summary measure. The first summary measure, 9) Count of Common Subclinical Symptoms numerates the sources of infection or inflammation that have the potential to confound hsCRP-based estimates of cardiovascular disease risk. High hsCRP concentrations triggered searches for non-cardiovascular (e.g. infectious or inflammatory) diseases which were counted and categorized.

The second summary measure, 10) Count of Infectious/ Inflammatory Diseases, therefore, counts and categorizes these conditions to enable investigators to control for potential confounding in hsCRP analyses. The third summary measure, 11) Diabetes Joint Classification, classifies respondents as having diabetes if they had a fasting glucose ≥ 126 mg/dl, non-fasting glucose ≥ 200 mg/dl, HbA1c ≥ 6.5%, self-reported history of diabetes except during pregnancy or used anti-diabetic medication in the past four weeks. Finally, 12) Anti-Diabetic Medication Use, flags those who report using medications in the past four weeks associated with one or more of the following therapeutic classification codes: antidiabetic agents, sulfonylureas, non-sulfonylureas, insulin, alpha-glucosidase inhibitors, thiazolidinediones, meglitinides, miscellaneous antidiabetic agents, antidiabetic combinations, dipeptidyl peptidase 4 inhibitors, amylin analogs or incretin mimetics. A final indicator, 13) Total Medications Currently using, captures drug use at the time of the survey.

In addition to these clinical measures, Add Health Respondents indicate whether they have ever been diagnosed by a doctor or nurse with any of the following conditions: asthma, cancer/leukemia, depression, diabetes, epilepsy/seizure disorder, high cholesterol, high blood pressure, bacterial vaginosis, cervicitis/ or mucopurulent cervicitis, chlamydia, genital herpes, genital warts, gonorrhea, hepatitis B, HIV/AIDS, human papilloma virus, pelvic inflammatory disease, syphilis, trichomoniasis, urethritis or vaginitis. For the purpose of this analysis, Sexually Transmitted Diseases (STD) are collapsed into a single category indicating whether a respondent had been diagnosed with at least one STDs.

Covariates-Self-Reported Health Awareness: The CDC categorizes weight as (i) Underweight, (ii) Normal Weight, (iii) Overweight, and (iv) Obese based on their BMI level. Compared to other measure of body fatness, BMI appears to be correlated with various metabolic and disease outcomes. Despite criticisms of this generic scale, in general, BMI is an inexpensive and easy-to-perform method of screening for weight category. This analysis examines whether one's own body perception aligns with their BMI classification. Add Health respondents classify their weight status as (i) Very Underweight, (ii) Slightly Underweight, (iii) Right Weight, (iv) Slightly Overweight, and (v) Very Overweight. Assuming that these categories represent self-assessments of BMI, they are aligned with the CDC categories as outlined in (Table 1a).

Given the very small proportion of the sample classified as very underweight, both underweight categories are combined into a single underweight group. Analysis will compare individual's assessment of their weight to the classification of their actual BMI to determine whether they systematically under, over or accurately estimate their body weight. The extent to which respondents over, under or accurately assess their weight is also examined and how mis-estimation varies by rural/urban status. These BMI classifications will also be compared to their reported intention to gain weight, lose weight, maintain weight or do nothing about their body weight, referred to as weight action. In addition to awareness of weight and necessary weight action, this study also examines individual assessment of their personal health which they classify as excellent, very good, food, fair or poor.

Statistical analysis: To accommodate the design of Add Health, statistical analysis needs to account for the sample weights, stratification, and clustering that was part of the sample design. Failure to account for sampling weights will affect the calculation of the point estimate while misspecification of the stratification or clustering will impact the calculation of the standard errors. Various procedures in SAS software package (SAS 9.4, Cary, NC) allow for correct estimation of variances/standard errors from complex samples. Rural and non-rural samples were test for statistically significant differences. All health issues, health related behaviors and self-reported health awareness aspects outlined above were examined. Appropriate logistic, ANOVA or linear testing techniques were used to test discrete, continues and categorical covariates for significant differences between rural and non-rural groups.

To explain observed differences in weight and weight classification, a multinomial logit model evaluates respondent over (1), under (-1) or accurate (0) BMI classification (measured relative to their actual weight classification) as a function of age, BMI level, gender, income, general health, rural residence and school enrollment. Since individuals chose many aspects of their domestic environment including geographic location (urban, rural, suburban, etc.), it is possible that residential self-selection could bias estimates by confounding differences in the locations themselves with rural-non-rural disparities. To ensure that estimates are robust to residential selection, weight misclassification was also estimated using a two-stage estimation selection procedure with discrete data following the framework popularized by [21,22].

Accounting for individual selection into rural areas, allows for evaluation of the differences in misclassification holding residential selection constant. Stage one-selection-frames a binary indicator for rural residency as a function of age, adolescent school enrollment and income. Stage two-response-contends that misclassification is a function of age, gender, BMI and general health status. BMI is used as an explanatory variable to allow for systematic various in misclassification along the BMI distribution.

Results

Demographic characteristics: Results of listed in Table II. Few demographic differences between rural and non-rural residents exist. They appear to have similar age, gender, household size and household composition profiles. Respondents in both groups are equally distributed male and females, live in 3-4 person households and are between 18 and 24 years old. Surprisingly, the proportion living with their biological mother and/or father does not significantly differ, however, they do present significantly different education

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and income profiles. Consistent with previous findings, rural residents have lower earned income and educational attainment. Three income measurements-parent's income, own earned income and own household income-were examined and show statistically lower income for rural residents who also have statistically lower educational attainment and fewer individuals enrolled in school. The racial/ethnic composition of rural and non-rural populations also differ significantly. Rural populations appear to be less diverse than others consisting of over 75 percent whites, compared to 65 percent in other areas. Minorities have a smaller representation in rural areas compared to non-rural communities (Table 2).

Health Issues/Indicators: There is a large difference in the health insurance status of the two groups. A higher percentage of rural residents have no health insurance, while less are covered by the insurance of a spouse or parent. They report that they held insurance for fewer months last year compared to non-rural young adults. While not directly related, it is likely that the lack of insurance coverage or full-year insurance coverage contributed to worse health outcomes by reducing the quantity and/or quality of care received [23]. Health disparities have also been linked to lack of preventative health services obtained [24].

One of the most unique aspects of the Add Health data is the large amount of medical diagnosis and clinical information available. Comparing diagnosis data between non-rural and rural adolescent and young adults show higher rates of asthma, epilepsy/seizure disorders, diabetes, high cholesterol, high cholesterol and high blood pressure in rural residents. Diabetes, high cholesterol and high blood pressure are known comorbidities of overweight and obesity and higher rates of excess weight among rural residents' likely attributes to the higher rates of related comorbidities [25,26]. Additionally, rural adolescents have higher triglycerides and hs-CRP indicating high levels of these fatty particles in the blood and greater risk of heart disease. Rural residents also show statistically higher rates of seizure disorders-a condition that has been growing in prevalence over the last decade, according to the CDC. Studies attributed these higher rates to the increased prevalence of untreated traumatic head injuries.

SBP Recover, PRR and BRS differ between rural and non-rural residents suggesting lower relative cardiac fitness, increased tendency towards Cardiovascular Disease (CVD) and higher likelihood of coronary issues or disorders. While detailed medical review of these factors lies outside the scope of this paper, they can be impacted by a variety of factors including our age, medical conditions, medications, diet, and fitness level.

Health Related Behaviors: There is no difference in exercise frequency, sleep or hours of television. The proportions of those who reported having used sedatives, pain killers, stimulants, tranquilizers or steroids in the last five years do not differ significantly. Rural residents consume alcohol and marijuana more frequently. These trends are supported by literature showing large differences were exhibited in marijuana use, both across nonmetropolitan-metropolitan status and across youth from metropolitan and nonmetropolitan counties, but that rates of illicit drug use were essentially the same regardless of location [27,28].

Self-Reported Health Awareness: Many of these health conditions are the result of excess body weight or obesity. Examination of BMI showed higher BMI among rural youth. While these BMI levels are highly unhealthy, it does not appear that rural respondents are aware of their situation or report an intention to change. Roughly equal proportions of both rural and non-rural residents report that they are overweight, despite a greater prevalence of overweight and obesity among rural residents. This indicates that either rural respondents are not aware of their BMI status or refuse to report themselves as such. Furthermore, they do not appear to be any more likely to report wanting to lose weight than their non-rural counterparts.

Finally, given the results presented above, rural and urban residents report similar self-assessments of their overall health. This lack of health awareness among rural residents has been found by other researchers as well [29]. The lack of awareness or refusal to accept their status is often perpetuated by the community at large and ignorance regarding the detrimental health effects of excess weight [30].

Misclassification Selection Model: Multinomial logit model estimates of weight misclassification show that misclassification type varies by age, gender, school enrollment, and general health status, but not by income or rural residency (Table 3). As individuals age and increase BMI they are less likely to underestimate and more likely to overestimate their weight. As adolescents leave school and experience health declines more likely to overestimate and less likely to underestimate their body weight. Blacks and females tend to overestimate weight. The multinomial showed that misclassification does not differ significantly for rural and non-rural residents when controlling for age, BMI, gender and other factors.

Multinomial odds ratio estimates suggest that BMI is the largest and most important driver of weight misclassification. Estimates suggest that the probability of overestimation increases as BMI increases with an odds ration of 36.054. Estimates suggest that BMI is the primary driver of misclassification. A two-stage sample selection model tests the robustness of these results. This technique controls for self-selection into rural areas before estimating the misclassification model. Two-stage estimates suggest that those factors associated with weight misclassification are similar for rural and non-rural residents. Controlling for residential self-selection, model results show that BMI is the primary determinant of misclassification and misclassification type [31,32] (Table 3 and 4).

Conclusion

While demographically similar, rural and non-rural youth have vastly different health profiles, behaviors and self-awareness. This study utilizes RUCA codes to classify adolescents as rural based on the OMB county classifications. OMB considers counties within census tracks with codes between 4 and 10 to be non-metropolitan. Adolescents within these non-metropolitan, rural areas have higher incidence of all major health conditions including epilepsy, high cholesterol, diabetes and high blood pressure. Not only are these health concern more prevalent among rural individuals compared to their urban counterparts, but their health concerns extend beyond measurable conditions to include a higher prevalence of unhealthy behaviors including drinking and marijuana use.

While generally similar in health, rural adolescents are more likely

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Table 3: Multinomial logit estimates of BMI miscalculation.

Model Fit Statistics			Dependent Variable: Misclassification		
Criterion	Intercept	Intercept, Covariates	Category	Code	N
AIC	20746022	17467953	Underestimate	-1	1113
SC	20746051	17468180	Accurately Estimate	0	4751
-2 Log L	20746018	17467921	Overestimate	1	2878

Analysis of Maximum Likelihood Estimates				Odds Ratio Estimates		
Parameter	Comparison	Estimate	Std Err	Estimate	95% Confidence Limits	
Intercept	Underestimate	9.6725***	0.8929			
Intercept	Overestimate	-12.4379***	0.8528			
Age	Underestimate	-0.0679**	0.0205	0.934	0.897	0.973
Age	Overestimate	0.012	0.0124	1.012	0.987	1.037
Female	Underestimate	-0.7809***	0.1071	0.458	0.371	0.566
Female	Overestimate	1.1303***	0.0969	3.097	2.556	3.751
Health	Underestimate	0.155**	0.0658	1.168	1.025	1.33
Health	Overestimate	-0.1931***	0.0442	0.824	0.755	0.9
lBMI	Underestimate	-3.2074***	0.283	0.04	0.023	0.071
lBMI	Overestimate	3.6044***	0.2524	36.759	22.301	60.589
School	Underestimate	0.1894	0.1503	1.209	0.897	1.628
School	Overestimate	-0.214**	0.1086	0.807	0.651	1.001
lIncome	Underestimate	-0.0205	0.0181	0.98	0.945	1.015
lIncome	Overestimate	-0.0164	0.0195	0.984	0.946	1.023
Black	Underestimate	0.5646***	0.1123	0.74	0.558	0.982
Black	Overestimate	-0.3006**	0.1427	1.759	1.408	2.196
Rural	Underestimate	0.0295	0.1267	1.03	0.801	1.324
Rural	Overestimate	0.1349	0.0891	1.144	0.959	1.365

Reference: 0=Accurately Estimate Weight
Dependent Variable: Misclassification= -1=Underestimate, 0=Accurately Estimate, 1=Overestimate
Estimates are weighted to account for survey sampling.

Table 4: 2 Stage residential selection model of weight misclassification.

Selection: Rural=0			Selection: Rural=1			
Heckman First Stage Discrete Selection Response Profile						
Index	Value		Index	Value		
N: Non-Rural	6114		N: Non-Rural	7040		
N: Rural	2140		N: Rural	1894		
Log Likelihood	-4649		Log Likelihood	-4566		
AIC	9307		AIC	9142		
Schwarz Criterion	9342		Schwarz Criterion	9178		
Likelihood Ratio (R)	150.2		Likelihood Ratio (R)	98.185		
Stage I: Parameter Estimates						
Parameter	Estimate	Std Err	Marginal Effect	Estimate	Standard	Marginal Effect
Intercept	0.706606***	0.130202		0.189208	0.129179	
Age	-0.049711***	0.004796	-0.009039	-0.03159***	0.00479	0.0090389
lIncome	-0.027847***	0.006366	-0.008311	-0.030036***	0.006267	0.008311
Highest Grade	0.053768**	0.016805	0.014939	0.05399**	0.01686	-0.0149391
School Enrollment	-0.410627***	0.043737	-0.092755	-0.335219***	0.043354	0.092755
Dependent Variable: Rural- 1=Rural, 0=Non-Rural						
Heckman Second Step Model Fit Summary						
Log Likelihood	-5239			Log Likelihood	-1508	
AIC	10493			AIC	3032	
Schwarz Criterion	10547			Schwarz Criterion	3077	
Stage II: Parameter Estimates						
Parameter	Estimate	Std. Err	Marginal Effect	Estimate	Standard	Marginal Effect
Intercept	-2.991752***	0.12232		-3.408589***	0.236078	
Age	0.01595***	0.002035	0.023197	0.023197***	0.003042	0.0159503
Female	0.313844***	0.014654	0.30955	0.30955***	0.024843	0.3138435
lBMI	0.952606***	0.035012	1.146196	1.146196***	0.056458	0.9526056
Black	0.112400***	0.017956	0.1124	0.193228***	0.029395	0.1932281
General Health	-0.07035***	0.008804	-0.074075	-0.074075***	0.015325	-0.07035
Lambda	-0.160641**	0.06013		-0.380529**	0.118997	

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Sigma	0.569997***	0.005155		0.536512***	0.008717	

Reference: 0=Accurately Estimate Weight
Dependent Variable: Misclassification= -1=Underestimate, 0=Accurately Estimate, 1=Overestimate
Estimates are weighted to account for survey sampling.

to be overweight or obese than urban. However, rural adolescents do not appear to be aware of the severity of their excess weight or the adverse health conditions that it causes-high cholesterol, high blood pressure and diabetes-which disproportionately impact rural youth. Disparate health outcomes could be partially attributed to the lack of preventative care. These findings that speak to the complexity of adolescent health. Not only does healthcare appear less readily available, but the ability of individuals in rural communities to afford health services is also questionable. Substantially lower income among individuals and household combined with lower educational attainment likely play an integral low in the worse health outcomes of rural adolescents.

Rural areas have a higher prevalence of overweight compared to non-rural. Individuals in rural areas are also more likely to misclassify their body weight. Regression analysis explores the determinants of over, under and accurate weight classification. Race, age, gender and health are related to weight misclassification, while income and rural residency are not. Robustness test verify that BMI is the primary determinant of BMI misclassification. As BMI increases, individuals are more likely to underestimate their weight status. Results transcend self-selection into rural areas showing that BMI misclassification is primarily determined by BMI level irrespective of residential location.

The rural environment is a unique and potentially challenging context for adolescent health. Lower income and education likely contribute to the disparate health circumstances of young, rural adults. Rural settings may present compounding barriers to health care for young adults, including isolation, insufficient financial resources, lack of available services, impaired geographic accessibility, and concerns for confidentiality within the small community settings. These conditions combined with the inherently different health infrastructure in rural areas necessitate new, less conventional health interventions to create sustained change and drive health equality.

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