Mean BMI Ratings and the Wealth of a Country

Introduction-

Obesity is a hot topic in today's world- with over 69.2% of adults in America being overweight, and a percentage of children being close behind. America is often referred to as the most overweight country. I work in a grocery store and am able to see the relationship between the kinds of foods that people buy (healthy vs. unhealthy, processed, natural) and whether they use government assistance to pay for it. Many times, but not all of the time, people whom use government assistance tend to buy more processed food, which tends to be less healthy. After seeing this relationship and doing a little research I made sense of this thought. Many Americans with low income tend to work more to make ends meet, and therefore do not have time to cook healthy meals for their family, causing them to eat snack food or fast food. Also, processed, unhealthy food often tends to be a lot cheaper then, say, organic completely natural food, so many people can not afford such healthy food. At first I wanted to study these patterns within American culture, but because of lack of data, I decided to study this on a worldly scale. I was led to think about what factors play into the overall health and obesity of citizens in a country. Does the wealth of a country determine how much the inhabitants have to eat, and in turn, determine their body mass index rating?

BMI is a number that is an indicator of body fatness, calculated from a persons weight and height. This is often a reliable number proven by other hi-tech, expensive procedures. A BMI measure of below 18.5 correlates to being underweight, from $\leq$18.5-24.9 correlates to being a healthy weight, 25.0-29.9 correlates to being overweight, and $\geq$30.0 correlates to being obese. (About BMI for Adults)

In this investigation I will compare the mean female BMI's of almost 140 countries to the GDP (gross domestic product) per capita PPP (purchasing power parity) in current international dollars. International dollars are a conversion of the money in each country that has the same purchasing power over GDP as the U.S. dollar has in the Unites States. GDP per capita based on purchasing power parity is a gross domestic product, converted to international dollars, that is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Basically, this is a measure of the wealth of the country and an indirect measure of the wealth of the common person, commonly used to compare. (Amadeo) (Purchasing Power Parity)

My aim in this investigation is to see if there is a relationship between the wealth of a particular country and the average BMI of the female in that country.

Investigation-

I will compare the mean BMI's of each country to the GDP per capita PPP of the country. The BMI's are taken from women ages 15-49. (The World Bank) (World Health Organization)

Country	GDP per capita, 2005 (x)	Average Female BMI (y)	x^2	y^2	$x * y$
Bangladesh	1144	19.8	1308736	392.04	22651.2
Eritrea	551	20.3	303601	412.09	11185.3
Ethiopia	620	19.9	384400	396.01	12338
Sri Lanka	3,550	20.5	12602500	420.25	72775
Dem Republic Congo	294	21.4	86436	457.96	6291.6
Vietnam	2161	21.0	4669921	441	45381
Burundi	453	22.0	205209	484	9966
Central African Republic	682	22.0	465124	484	15004
Zambia	1157	22.0	1338649	484	25454
Kenya	1340	22.4	1795600	501.76	30016
Rwanda	820	22.2	672400	492.84	18204
Burkina Faso	1072	21.7	1149184	470.89	23262.4
India	2234	21.4	4990756	457.96	47807.6
Afghanistan	828	21.8	685584	475.24	18050.4
Uganda	902	22.4	813604	501.76	20204.8
Chad	1343	22.1	1803649	488.41	29680.3
Gambia	1642	22.5	2696164	506.25	36945
Indonesia	3141	22.7	9865881	515.29	71300.7
Madagascar	849	22.2	720801	492.84	18847.8
Mozambique	662	22.7	438244	515.29	15027.4
Niger	601	22.3	361201	497.29	13402.3
Congo	3372	22.7	11370384	515.29	76544.4
Malawi	640	22.6	409600	510.76	14464
Cambodia	1508	21.7	2274064	470.89	32723.6
Tanzania	1070	22.9	1144900	524.41	24503
Japan	30,441	21.7	926654481	470.89	660569.7

Sudan	1514	23.1	2292196	533.61	34973.4
Namibia	5341	23.4	28526281	547.56	124979.4
Pakistan	2154	22.8	4639716	519.84	49111.2
Singapore	45,374	22.7	2058799876	515.29	1029989.8
Guinea	917	23.4	840889	547.56	21457.8
Mali	976	23.7	952576	561.69	23131.2
Togo	838	23.4	702244	547.56	19609.2
Senegal	1618	24.1	2617924	580.81	38993.8
Yemen	2293	23.1	5257849	533.61	52968.3
Philippines	3041	23.3	9247681	542.89	70855.3
Angola	3343	23.6	11175649	556.96	78894.8
Nigeria	1753	23.6	3073009	556.96	41370.8
Benin	1279	24.4	1635841	595.36	31207.6
Ghana	1222	23.1	1493284	533.61	28228.2
Malaysia	12,131	24.3	147161161	590.49	294783.3
Papua New Guinea	1866	23.4	3481956	547.56	43664.4
Thailand	6,791	24.1	46117681	580.81	163663.1
Sierra Leone	855	25.0	731025	625	21375
Liberia	337	24.6	113569	605.16	8290.2
China	4115	23.4	16933225	547.56	96291
Romania	9361	24.2	87628321	585.64	226536.2
Haiti	1033	26.1	1067089	681.21	26961.3
Tajikistan	1343	24.9	1803649	620.01	33440.7
Estonia	16,548	23.5	273836304	552.25	388878
Gabon	12,932	25.5	167236624	650.25	329766
Kazakhstan	8699	24.0	75672601	576	208776
France	29,453	23.9	867479209	571.21	703926.7
Algeria	6942	25.1	48191364	630.01	174244.2
Cameroon	1922	24.6	3694084	605.16	47281.2
Moldova	2362	25.2	5579044	635.04	59522.4

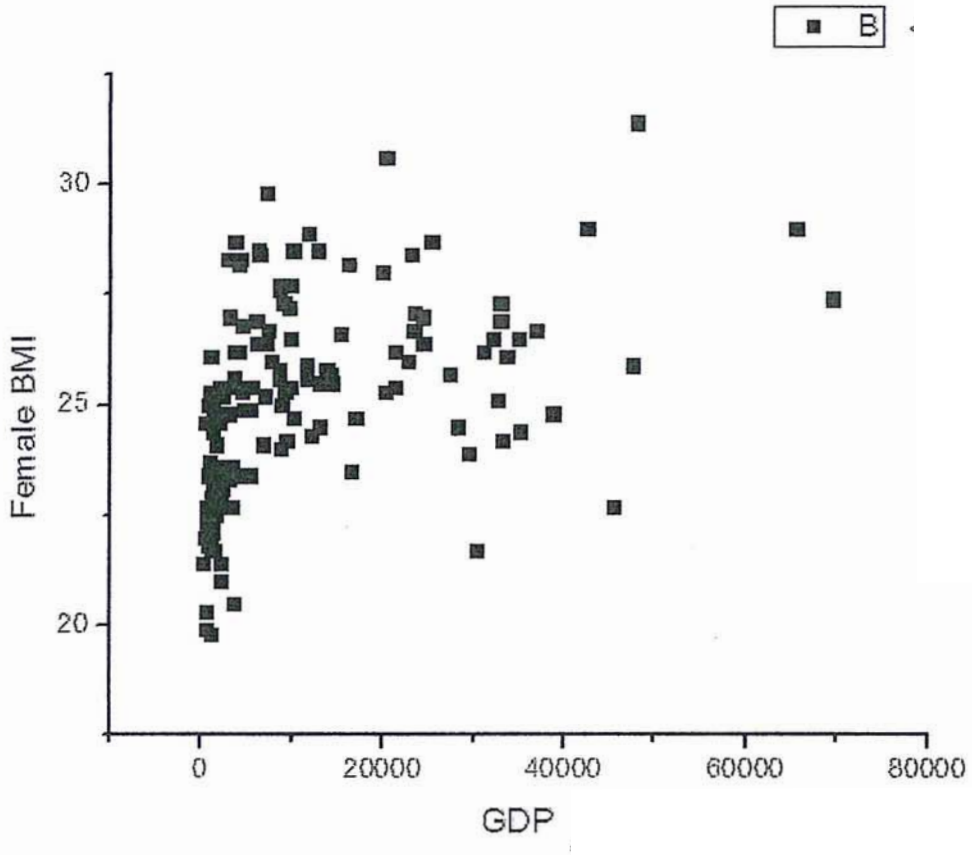
Timor-Leste	985	25.3	970225	640.09	24920.5
Morocco	3540	26.2	12531600	686.44	92748
Swaziland	4518	25.4	20412324	645.16	114757.2
Honduras	3268	25.4	10679824	645.16	83007.2
Oman	20,273	25.3	410994529	640.09	512906.9
Ukraine	5583	25.4	31169889	645.16	141808.2
Denmark	33,193	24.2	1101775249	585.64	803270.6
Uzbekistan	2001	25.4	4004001	645.16	50825.4
Turkmenistan	4762	24.9	22676644	620.01	118573.8
Botswana	11541	25.6	133194681	655.36	295449.6
Georgia	3610	25.6	13032100	655.36	92416
Iraq	3014	25.6	9084196	655.36	77158.4
Latvia	13,040	24.8	170041600	615.04	323392
Ireland	38,795	24.5	1505052025	600.25	950477.5
Netherlands	35,104	24.8	1232290816	615.04	870579.2
Italy	28,280	24.4	799758400	595.36	690032
Belgium	32,189	24.5	1036131721	600.25	788630.5
Mauritania	1865	26.5	3478225	702.25	49422.5
Poland	13,784	24.8	189998656	615.04	341843.2
Ecuador	7129	25.8	50822641	665.64	183928.2
Macedonia	7677	26.4	58936329	696.96	202672.8
Mauritius	10,158	26.0	103184964	676	264108
Norway	47,626	24.7	2268235876	610.09	1176362.2
Paraguay	4554	25.9	20738916	670.81	117948.6
South Korea	22,783	25.3	519065089	640.09	576409.9
El Salvador	5382	26.0	28965924	676	139932
Sweden	32,703	24.9	1069486209	620.01	814304.7
Hungary	16,975	25.1	288150625	630.01	426072.5
Lithuania	14,197	24.7	201554809	610.09	350665.9
Armenia	4166	25.7	17355556	660.49	107066.2

Panama	8819	26.2	77774761	686.44	231057.8
Bulgaria	9809	25.0	96216481	625	245225
Spain	27,392	25.4	750321664	645.16	695756.8
Bosnia and Herzegovina	6179	25.7	38180041	660.49	158800.3
Libya	14,454	26.4	208918116	696.96	381585.6
Portugal	21,369	25.5	456634161	650.25	544909.5
Serbia	8517	25.4	72539289	645.16	216331.8
Albania	5998	25.8	35976004	665.64	154748.4
Iran	9173	26.9	84143929	723.61	246753.7
Croatia	15,332	25.3	235070224	640.09	387899.6
Lebanon	9,753	26.6	95121009	707.56	259429.8
Brazil	8502	26.5	72284004	702.25	225303
Czech Republic	21,264	25.6	452157696	655.36	544358.4
Switzerland	36,964	26.2	1366337296	686.44	968456.8
Cyprus	24,408	26.7	595750464	712.89	651693.6
Azerbaijan	4496	26.4	20214016	696.96	118694.4
Slovakia	16,175	26.8	261630625	718.24	433490
South Africa	8597	28.2	73908409	795.24	242435.4
Turkey	11532	27.6	132987024	761.76	318283.2
Finland	33,626	25.9	1130707876	670.81	870913.4
Austria	33,626	26.1	1130707876	681.21	877638.6
Israel	23,340	26.7	544755600	712.89	623178
Slovenia	23,476	27.1	551122576	734.41	636199.6
Colombia	7280	26.7	52998400	712.89	194376
Canada	35,033	26.5	1227311089	702.25	928374.5
Costa Rica	9019	27.3	81342361	745.29	246218.7
Qatar	69,498	27.4	4829972004	750.76	1904245.2
Dominican Republic	6326	28.5	40018276	812.25	180291
UK	32, 958	26.9	1086229764	723.61	886570.2

Belarus	8,640	27.7	74649600	767.29	239328	
Germany	31,115	26.2	968143225	686.44	815213	
Jordan	4335	28.3	18792225	800.89	122680.5	
Uruguay	9626	27.2	92659876	739.84	261827.2	
Peru	6349	28.4	40309801	806.56	180311.6	
Jamaica	7083	29.8	50168889	888.04	211073.4	
Mongolia	2885	28.3	8323225	800.89	81645.5	
Saudi Arabia	19,869	28.0	394777161	784	556332	
Guatemala	4074	28.2	16597476	795.24	114886.8	
Bahrain	23,131	28.4	535043161	806.56	656920.4	
Nicaragua	3013	28.9	9078169	835.21	87075.7	
Greece	24,348	27.0	592825104	729	657396	
Bolivia	3,688	28.7	13601344	823.69	105845.6	
Australia	32,956	27.3	1086097936	745.29	899698.8	
Venezuela	9869	27.7	97397161	767.29	273371.3	
Chile	12,773	28.5	163149529	812.25	364030.5	
United Arab Emirates	65,573	29.0	4299818329	841	1901617	
New Zealand	25,308	28.7	640494864	823.69	726339.6	
Mexico	11,723	28.9	137428729	835.21	338794.7	
Argentina	10,083	28.5	101666889	812.25	287365.5	
Trinidad and Tobago	20,334	30.6	413471556	936.36	622220.4	
USA	42,516	29.0	1807610256	841	1232964	
Kuwait	48,096	31.4	2313225216	985.96	1510214.4	
Σ	1654427	3467.5	45877627393			

87860.31

After attaining this data, I graphed the GDP of the country vs. the average BMI. The graph is as follows-



Calculations of results

I will use math to see if there is a relationship between the financial income of various countries and the mean female BMI within that country.

A. Linear Regression/Line of Best Fit

The linear regression line is also the line of best fit- it shows the general trend in the data.

Equation-

$y=mx+b$

$$Slope = m = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

$$Intercept = b = \frac{(\sum y) - m(\sum x)}{n}$$

1. First, find the slope

$$Slope = m = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

$(\sum xy)$ Is the sum of x*y of each point. This is the number at the bottom of the sixth last column.

$(\sum x)(\sum y)$ is the product of the sum of the x's and the sum of the y's (second column. last row multiplied by third column, last row)

$(\sum x^2)$ Is the x of each point squared. You then add all of these numbers to get the sum. This is the number at the bottom of the fourth column.

$(\sum x)^2$ Is the sum of all of the x's, and then this number is squared. This is the number at the bottom of the second column. squared.

n is the total number of data points in the investigation, or 138

$$Slope = m = \frac{n(43247829.9) - (1654427)(3467.5)}{n(45877627393) - (1654427)^2}$$

$$Slope = m = \frac{(138)(43247829.9) - 5736725622.5}{(138)(45877627393) - 2737 1286988329}$$

$$Slope = m = \frac{5968200526.2 - 5736725622.5}{6331112580234 - 2737 1286988329}$$

$$Slope = m = \frac{231474903}{3593983881905}$$

$m=0.0000644062164178$

2. Next, find intercept.

$$Intercept = b = \frac{(\sum y) - m(\sum x)}{n}$$

$(\sum y)$ Is the sum of all the y's. This is the number at the bottom of the third column.

$(\sum x)$ Is the sum of all the x's. This is the number at the bottom of the second column.

n is the total number of data points in the investigation.

$$Intercept\ b = \frac{3467.5 - m(1654427)}{138}$$

$$Intercept\ b = \frac{3467.5 - (.0000644)(1654427)}{138}$$

$$Intercept\ b = \frac{3467.5 - 106.555}{138}$$

$$Intercept\ b = \frac{3360.944}{138}$$

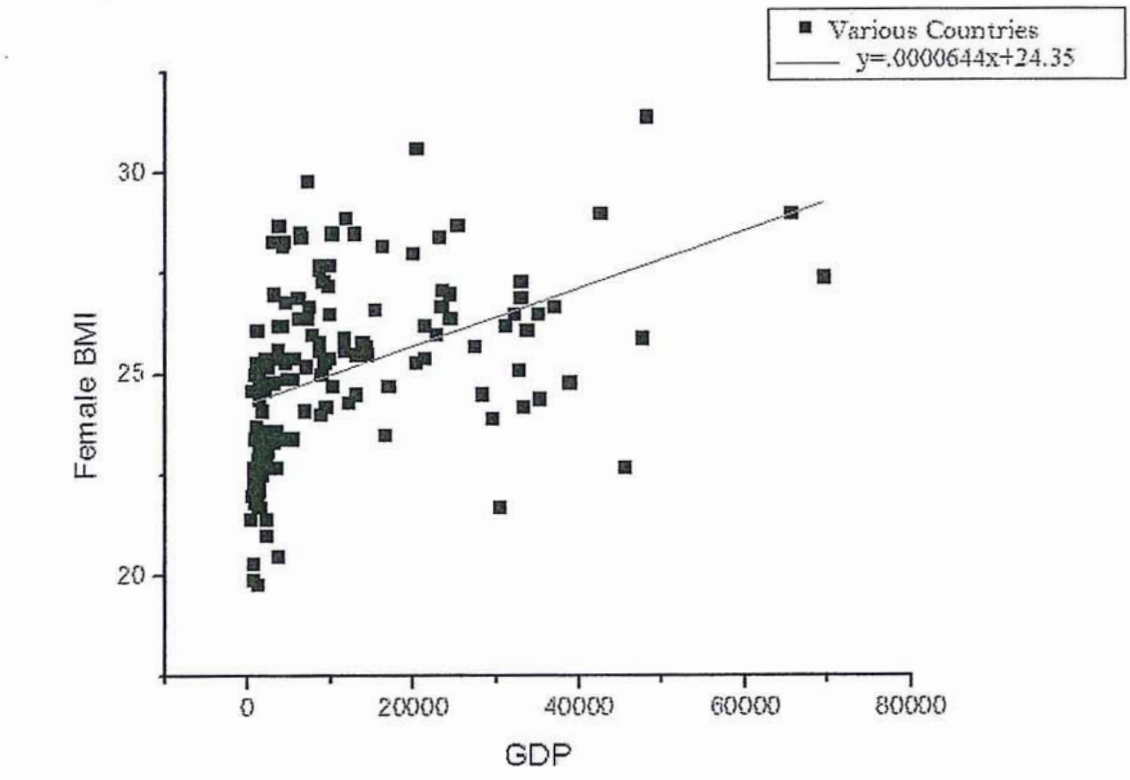
$b=24.354671134$

3. Put it together for full equation

Full Equation of line-

y=.0000644x+24.35

Scatter plot with included linear regression-



B. Find the "R" value- this value shows how well the data actually fits into the calculated linear regression line. If the number is close to 1 (positive slope) or -1 (negative slope) then the line fits the data well. As the R value gets closer to 0, the linear regression line and the data do not fit each other as well.

1. Find the value-

$$coefficientofcorrelation = r = \frac{n(\sum xy) - (\sum x)(\sum y)}{[n(\sum x^2) - (\sum x)^2]^{.5}[n(\sum y^2) - (\sum y)^2]^{.5}}$$

$(\sum xy)$ is the sum of x*y of each point. This is the number at the bottom of the sixth last column.

$(\sum x)(\sum y)$ is the product of the sum of the x's and the sum of the y's (second column, last row multiplied by third column, last row)

$(\sum x^2)$ Is the x of each point squared. You then add all of these numbers to get the sum. This is the number at the bottom of the fourth column.

$(\sum x)^2$ Is the sum of all of the x's, and then this number is squared. This is the number at the bottom of the second column, squared.

$(\sum y^2)$ Is the y of each point squared. You then add all of these numbers to get the sum. This is the number at the bottom of the fifth column.

$(\sum x)^2$ Is the sum of all of the x's, and then this number is squared. This is the number at the bottom of the second column, squared.

n is the number of data points in the investigation.

$$coefficientofcorrelation = r = \frac{n(\sum xy) - (\sum x)(\sum y)}{[n(\sum x^2) - (\sum x)^2]^{.5}[n(\sum y^2) - (\sum y)^2]^{.5}}$$

$$r = \frac{n(43247829.9) - (1654427)(3467.5)}{[n(45877627393) - (1654427)^2]^{.5}[n(87860.31) - (3467.5)^2]^{.5}}$$

$$r = \frac{(138)(43247829.9) - 57367256225}{[(138)(45877627393) - 2737128698329]^{.5}[(138)(87860.31) - 12023556.25]^{.5}}$$

$(\sum x)^2$ Is the sum of all of the x's, and then this number is squared. This is the number at the bottom of the second column, squared.

$(\sum y^2)$ Is the y of each point squared. You then add all of these numbers to get the sum. This is the number at the bottom of the fifth column.

$(\sum x)^2$ Is the sum of all of the x's, and then this number is squared. This is the number at the bottom of the second column, squared.

n is the number of data points in the investigation.

$$coefficientofcorrelation = r = \frac{n(\sum xy) - (\sum x)(\sum y)}{[n(\sum x^2) - (\sum x)^2]^{.5}[n(\sum y^2) - (\sum y)^2]^{.5}}$$

$$r = \frac{n(43247829.9) - (1654427)(3467.5)}{[n(45877627393) - (1654427)^2]^{.5}[n(87860.31) - (3467.5)^2]^{.5}}$$

$$r = \frac{(138)(43247829.9) - 5736725622.5}{[(138)(45877627393) - 2737128698329]^{.5}[(138)(87860.31) - 12023556.25]^{.5}}$$

$$r = \frac{5968200526.2 - 5736725622.5}{[6331112580234 - 2737128698329]^{.5}[12124722.78 - 12023556.25]^{.5}}$$

$$r = \frac{231474903.7}{[3593983881905]^{.5}[101166.53]^{.5}}$$

$$r = \frac{231474903.7}{(1895780.5468)(318.06686)}$$

$$r = \frac{231474903.7}{602963335.42}$$

R=0.383882

Conclusion-

To show a strong correlation, the R value should be close to 1 for a positively sloped line, and close to -1 for a negatively sloped line. The closer the R value is to zero, the less correlated the data is. Since the R value is a very small number, very close to zero (0.383882), we know that the data barley correlates.

Why is this? One may think that there should be an obvious correlation between how much money a person has and how much food they are able to buy, which would mean, in

Sample size: 138

Correlation coefficient (r): 0.38388171163711

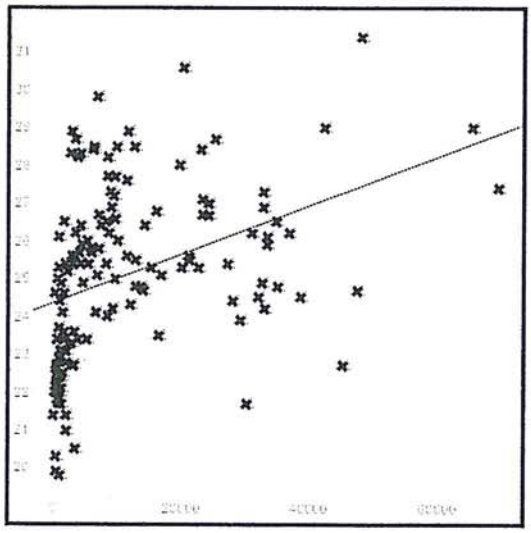
Linear regression Scatter plot

Enter the x,y values (numbers only):

3144,19.5
551,20.3
620,18.9
3550,20.5
294,21.4
2161,21.0
458,22.0
682,22.0
1157,22.0
1349,22.4

SUBMIT DATA RESET

Sample size: 138
Mean x (x̄): 11988.601449275
Mean y (ȳ): 25.126811594203
Intercept (a): 24.354671134714
Slope (b): 6.4406216417783E-5
Regression line equation: y=24.354671134714+6.4406216417783E-5x



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To check R value- http://www.alcula.com/calculators/statistics/correlation-coefficient/

To check line equation- http://www.alcula.com/calculators/statistics/linear-regression/