

CALORIES, CARIES & CULTURE:
THE RELATIONSHIP OF
BODY MASS INDEX & ORAL HEALTH STATUS
IN 3rd GRADE SCHOOL CHILDREN

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Objective

To investigate the association between
body mass index (BMI), and *oral health outcomes*
in 3rd grade Minnesota school children

measured by the basic screening survey (BSS) including
caries experience,
sealant prevalence, and
treatment urgency.

Calories, Caries, & Culture: Measures

Calories
BMI

Caries
Untreated Caries
Caries Experience

Culture
Age
Gender
Race / Ethnicity
Urban/Rural
Sealant on Molar
F&RL \geq 50%

Provisos

- BSS/BMI analysis should be considered preliminary, not definitive
- This is a team effort
- BSS results have been published
- BMI analysis is ongoing

BSS Analysis Team

- Epidemiologists – Jon Roesler, Ayo Adeniyi
- Obesity Epidemiologist – David Simmons
- Evaluator – Bilquis Khan
- Principal Investigator – Merry Jo Theole
- Data Collection Coordinator – Barbara Hann
- Biostatistician – Anna Gaichas

Identifying the Issue

2 Background Papers

2 Literature Reviews

2 Examples Looking at BMI & Caries

Background Literature 1

- Diet plays an important role in the obesity epidemic
- Dietary habits in children have suffered major changes in the last thirty years
- Consumption of soft drinks is associated with reduced vitamin and mineral intake and an excess of dietary carbohydrates

Gidding SS, Dennison BA, Birch LL, Daniels SR, Gilman MW, Lichtenstein AH, et al. American Heart Association dietary recommendations for children and adolescents: a guide for practitioners. *Pediatrics* 2006; 117:544–59.

Background Literature 2

- The oral health implications of nutritional practices were demonstrated by a review of children’s eating habits in the United States between 1988 and 1994.
- That study found an association between poor dietary practices (meal fragmentation, missed breakfast, low fruit, and higher carbohydrate intake) and caries.

Dye BA, Shenkin JD, Ogden CL, Marshall TA, Levy SM, Kanellis MJ. The relationship between healthful eating practices and dental caries in children aged 2–5 years in the United States, 1988–1994. *J Am Dent Assoc* 2004; 135: 55–66.

Lit Review 1: Obesity and dental caries—A systematic review.

PURPOSE:
To undertake a systematic review about the relationship between obesity in childhood, adolescence and/or adulthood and the prevalence of dental caries.

METHODS:
•Bireme, Medline, ISI, Cochrane Library and the internet search from 1984-2004
•Search terms were ‘obesity’ and ‘dental caries’
•Inclusion criteria : Defined obesity (body mass index) and dental caries (total number of decayed, and filled teeth - DFT/DFS/dfn/dfs) in their subjects
•Paper excluded: articles on reviews, dietary guidelines, policy statements, papers related to oral health and nutrition deficiency–underweight, and with no relation between obesity and dental caries prevalence or dental health problems

RESULTS:
No systematic review has focused on correlating obesity and caries and only three studies had high levels of evidence.

CONCLUSION:
Only one study with high level of evidence showed direct association between obesity and dental caries. In view of the findings, further well-designed randomised studies are needed to demonstrate the relationship between dental caries and obesity.

[Pinto A et al. J Dent Educ. 2007;71\(1\):1438-1440](#)
Obesity and dental caries—A systematic review.
[Pinto A, et al. J Dent Educ. 2007;71\(1\):1438-1440](#)

Lit Review 2 Body mass index and dental caries in children and adolescents: a systematic review of literature published 2004 to 2011

THE OBJECTIVE:
To undertake an updated systematic review of the relationship between body mass index and dental caries in children and adolescents

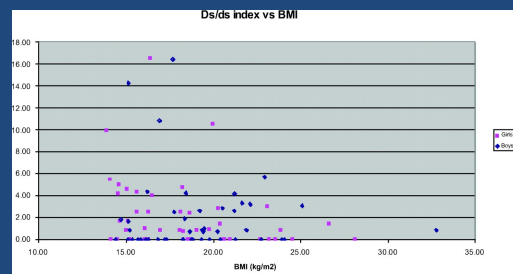
METHOD:
Searched Medline, ISI, Cochrane, Scopus, Global Health and CINAHL databases and conducted lateral searches from reference lists for papers published from 2004 to 2011, inclusive. All empirical papers that tested associations between body mass index and dental caries in child and adolescent populations (aged 0 to 18 years) were included.

RESULTS:
Dental caries is associated with both high and low body mass index.

CONCLUSION:
A non-linear association between body mass index and dental caries may account for inconsistent findings in previous research. We recommend future research investigate the nature of the association between body mass index and dental caries in samples that include a full range of body mass index scores, and explore how factors such as socioeconomic status mediate the association between body mass index and dental caries.

[Dye BA, et al. J Am Dent Assoc. 2011 Oct;142\(10\):1481-1490](#)
Body mass index and dental caries in children and adolescents: a systematic review of literature published 2004 to 2011.

Example 1 Data distribution and Spearman’s correlation.



[Pinto A et al. J Dent Educ. 2007;71\(1\):1438-1440](#)
Is There an Association Between Weight and Dental Caries Among Pediatric Patients in an Urban Dental School? A Correlation Study

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Example 2

Table 2: Caries experience among the three BMI strata

	BMI	Mean	SD	p-value	Post-hoc comparisons
DT	Low normal weight (1)	1.49	1.54	< 0.001	2 > 1, 3 > 1
	Overweight (2)	2.41	1.80		
	Obesity (3)	3.44	2.31		
MT	Low normal weight (1)	0.06	0.34	0.708	—
	Overweight (2)	0.05	0.21		
	Obesity (3)	0.00	0.00		
FT	Low normal weight (1)	0.10	0.46	0.263	—
	Overweight (2)	0.10	0.43		
	Obesity (3)	0.31	1.25		
DMFT	Low normal weight (1)	1.66	1.62	< 0.001	3 > 2 > 1
	Overweight (2)	2.56	1.86		
	Obesity (3)	3.75	2.44		

p ≤ 0.05 was considered significant

DT: Decayed Teeth, MT: Missing Teeth, FT: Filled Teeth, DMFT: Decayed Missing Filled Teeth, BMI: Body Mass Index

[Dye BA, et al. J Am Dent Assoc. 2011 Oct;142\(10\):1481-1490](#)
Relationship between body mass index and dental caries among adolescent children in South India.

Table 3: Correlation analysis between strata of BMI and DT, MT, FT and DMFT

	Spearman's rho	DT	MT	FT	DMFT
Correlation coefficient	0.254 (**)	-0.010	0.013	0.242 (**)	
BMI <i>p</i> -value	< 0.001	0.837	0.774	< 0.001	
n	463	463	463	463	

** Correlation is significant at the 0.01 level (2-tailed).

DT: Decayed Teeth, MT: Missing Teeth, FT: Filled Teeth, DMFT: Decayed Missing Filled Teeth, BMI: Body Mass Index

2011 Oct;60(5):581-6.
 Relationship between body mass index and dental caries among adolescent children in South India.
[Thangavelu M, Sankar D, Sankar S, Sankar D.](#)

Table 4: Multivariate analysis to determine the possible risk factors for caries occurrence in the study population

Variable	df	<i>p</i> -value	Adjusted Odds ratio	95% CI	
				Lower	Upper
Age	1	0.192	1.36	0.86	2.14
School (private)	1	0.924	0.97	0.47	2.00
Sex (male)	1	0.047	2.09	1.01	4.33
BMI (Overweight/obese)	1	< 0.001	3.68	1.79	7.56
Frequency of sweet consumption (More than once)	1	0.015	3.13	1.25	7.85

p ≤ 0.05 was considered significant

Binomial logistic regression with predictor variables being age, sex (female – reference category) school (government school – reference category), BMI (low normal weight-reference category) and frequency of sweet consumption (once daily-reference category). Outcome variable being caries experience. df – degrees of freedom, CI – confidence interval

2011 Oct;60(5):581-6.
 Relationship between body mass index and dental caries among adolescent children in South India.
[Thangavelu M, Sankar D, Sankar S, Sankar D.](#)

Methods

Basic Screening Survey Measured

- Height and weight of children to calculate BMI
- Caries Experience
- Sealant prevalence
- Treatment urgency

Other Measures

- Date of birth
- Gender
- Race/ethnicity
- Urban/rural and proportion of children eligible for Free and Reduced Lunch Program

Survey Participants

- 3rd grade Minnesota school children

Sample Size

- Participants were actively consented
- 40 randomly selected schools



Protecting, maintaining and improving the health of all Minnesotans

Free Health Screening Permission

Free health screening for third graders at your child's school on December 18, 2009

Please fill out and sign the entire top part of this permission form. The screening is voluntary and your child's information will remain confidential. Thank you!
 Return this form to your child's teacher by December 17, 2009

I have read and understand the parent letter and:

- Yes I give permission for my child to participate in the free oral health screening.
 No I do not give permission for my child to participate in the free oral health screening.
 Yes I give permission to measure my child's height and weight.
 No I do not give permission to measure my child's height and weight.

Child's name: _____

Parent/Guardian Signature: _____ Date: _____ Month/Day/Year

Address: _____ Home address City State Zip code

Child's birthdate: _____ Month/Day/Year

Ethnicity: (check one) Hispanic or Latino Not-Hispanic or Latino

Race: (check all that apply) American Indian/Alaskan Native Asian Black/African American Native Hawaiian/Pacific Islander White Other _____

Gender: Male Female

This box for office use only is for

Screener Code Date // School code Consent OH Consent H&W Student refuse Absent Moved

Oral health

Untreated Cavities: 0=No untreated cavities 1=Untreated cavities
 Sealants on Permanent Molars: 0=No Sealants 1=Sealants

Treated Decay: 0=No Caries Experience 1=Caries Experience
 Treatment Urgency: 0=No obvious problem 1=Early dental care 2=Urgent care

Height Weight

Height
 1. inches 2. inches 3. inches Comment: _____
 Weight
 1. Pounds 2. Pounds 3. Pounds





Calorie Measures BMI Percentiles (Age & Gender)

$< 5\%$	Underweight
$5\% \text{ to } < 85\%$	Normal
$\geq 85\% \text{ to } < 95\%$	Overweight
$\geq 95\%$	Obese

Caries Measures

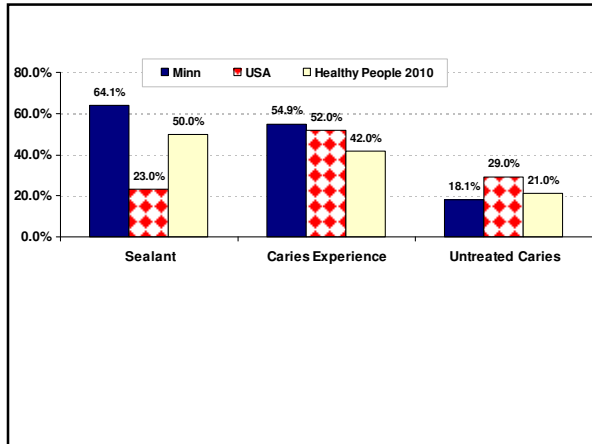
Untreated Caries
Caries Experience (treated and/or untreated)

Culture Measures

Urban / Rural
F&RL $\geq 50\%$ 50% or more of the children are eligible for Free or Reduced-price Lunch
Gender
Race
??Sealants??

Results

BSS 3rd Grade Students, 2010 Minnesota. N = student screened	N: Sampledschools*	Student pop
3rd Grade Class/Schools Statewide* <i>student n=1,766</i>	40	59,274
Free & Reduced Lunches		
Schools LE 25% FRL eligible, <i>student n=454</i>	9	15,239
Schools 26-49% FRL eligible, <i>student n=953</i>	18	31,984
Schools 50-74% FRL eligible, <i>student n=205</i>	8	6,882
Schools GE 75% FRL eligible, <i>student n=154</i>	5	5,169
Race		
White, non-Hispanic, <i>n=1,345</i>	n/a	45,143
Non-white, non-Hispanic, <i>n=252</i>	n/a	6,458
Hispanic, <i>n=90</i>	n/a	3,023
Unknown/missing, <i>n=79</i>	n/a	2,650
Sex		
Male, <i>n=669</i>	n/a	29,169
Female, <i>n=826</i>	n/a	27,722
Unknown/missing <i>n=71 Excluded from analysis</i>	n/a	2,383
Region		
Rural, <i>student n=1,103</i>	26	37,023
Urban, 7-County Metro, <i>student n=663</i>	14	22,251



BSS 3rd Grade Students, 2010 Minnesota, note: Data presented as for non-sealant schools except where noted. ** Schools included 3rd Grade Caries Schools School n=720	n	Sampled schools	Student n=99	Sealant on Molar		Caries Experience		Untreated Caries		Treated Decay		Treatment Urgency: None		Treatment Urgency: Early Care		Treatment Urgency: Urgent Care								
				%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI					
Sealant schools**	11	271	55	48.2	54.9	50.0	35.2	32.1	47.4	42.4	32.4	31.4	32.4	10.0	14.1	10.4	1.7	0.1						
U.S. Average (U.S.†)	100	271	23.0	23.0	52.0	52.0	28.0	28.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0						
HP 2010 Target (U.S.†)	100	271	50.0	50.0	42.0	42.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0						
Free & Reduced Lunches																								
Schools LE 20% FR, eligible, student n=64	11	271	69.5	69.5	75.3	75.3	52.1	52.1	10.9	10.9	11.3	11.3	41.9	33.1	40.3	34.9	35.0	11.0	0.9	10.0	0.1	0.1		
Schools 20-49% FR, eligible, student n=653	11	271	37.8	37.8	50.0	50.0	71.3	71.3	11.2	11.2	20.0	20.0	35.0	35.0	31.0	31.0	15.0	15.0	17.6	17.6	16.0	16.0		
Schools 50-74% FR, eligible, student n=209	11	271	24.0	24.0	44.0	44.0	60.0	60.0	74.0	74.0	26.0	26.0	14.0	14.0	26.0	26.0	10.0	10.0	24.0	24.0	24.0	24.0		
Schools 75-99% FR, eligible, student n=154	11	271	4.2	4.2	29.0	29.0	84.0	84.0	15.0	15.0	10.0	10.0	47.0	47.0	33.0	33.0	62.0	62.0	74.0	74.0	14.0	14.0		
Rate																								
Minn, non-eligible, n=1,365	106	45,149	56.6	56.6	62.0	62.0	52.1	52.1	37.0	37.0	33.0	33.0	46.6	41.1	50.3	39.0	79.0	64.0	15.6	13.9	18.4	1.3	0.1	
Non-eligible, non-eligible, n=252	106	4,048	14.8	14.8	40.0	40.0	85.0	85.0	13.0	13.0	10.0	10.0	45.0	34.0	44.0	44.0	42.0	21.0	16.0	28.0	4.0	1.0		
Non-eligible, n=30	106	2,033	48.4	48.4	40.0	40.0	68.0	68.0	17.0	17.0	16.0	16.0	32.0	43.0	41.0	38.0	36.0	40.0	14.0	14.0	20.0	0.0	0.0	
Non-eligible, n=79	106	2,260	65.5	65.5	71.0	71.0	55.0	55.0	24.0	24.0	22.0	22.0	46.0	34.0	39.0	35.0	38.0	21.0	19.0	25.0	2.0	0.1		
Sex																								
Male, n=467	106	39,109	62.0	62.0	67.0	67.0	66.0	66.0	16.0	16.0	11.0	11.0	46.0	38.0	47.0	40.0	85.0	71.0	16.0	14.0	20.0	1.0	0.1	
Female, n=426	106	27,102	66.0	66.0	61.0	61.0	53.0	53.0	20.0	20.0	23.0	23.0	40.0	43.0	35.0	31.0	76.0	65.0	16.0	13.0	19.0	1.0	0.1	
Missing/missing, n=71	106	2,360																						
Region																								
Field, student n=1,102	106	37,202	63.0	63.0	69.0	69.0	51.0	51.0	42.0	42.0	13.0	13.0	48.0	43.0	50.0	38.0	76.0	64.0	18.0	16.0	21.0	1.0	0.1	
Urban 7 County Metro, student n=693	14	22,281	64.0	64.0	71.0	71.0	51.0	51.0	48.0	48.0	15.0	15.0	44.0	37.0	52.0	39.0	78.0	69.0	14.0	9.0	19.0	1.0	0.1	

Results

Preliminary results indicate that caries status, lack of sealants, unhealthy weight (over/underweight) and attendance at a school with a high proportion of free and reduced lunches are positively correlated.

Analyses

Bivariate
Multivariate

Bivariate

- BMI &
 - Untreated Caries
 - BMI & Caries Experience
- Sealant on Molar
- Free & Reduced Lunch

BMI By Untreated Caries

Table of BMI_pct_rank by uc2			
BMI_pct_rank	uc2	Frequency	Row Percent
1 obese	1) Yes	61	25
	2) No	183	75
	Total	244	100
2 overweight	1) Yes	39	14.6
	2) No	229	85.4
	Total	268	100
3 normal	1) Yes	202	17.5
	2) No	950	82.5
	Total	1152	100
4 underweight	1) Yes	4	16.7
	2) No	20	83.3
	Total	24	100
Total	1) Yes	306	18.1
	2) No	1382	81.9
	Total	1688	100

Frequency Missing = 36

BMI by Caries Experience

Table of BMI percent rank by caries experience			
BMI_pctl_rank	Caries Experience	Frequency	Row Percent
1 obese	1) Yes	147	60.2
	2) No	97	39.8
	Total	244	100
2 overweight	1) Yes	147	54.6
	2) No	122	45.4
	Total	269	100
3 normal	1) Yes	614	53.4
	2) No	536	46.6
	Total	1150	100
4 underweight	1) Yes	15	62.5
	2) No	9	37.5
	Total	24	100
Total	1) Yes	923	54.7
	2) No	764	45.3
	Total	1687	100

Frequency Missing = 37

BMI by Sealant on Molar

Table of BMI_pctl_rank by sm2			
BMI_pctl_rank	Sealant on Molar	Frequency	Row Percent
1 obese	0) No	90	37.2
	1) Yes	152	62.8
	Total	242	100
2 overweight	0) No	95	35.7
	1) Yes	171	64.3
	Total	266	100
3 normal	0) No	405	35.2
	1) Yes	746	64.8
	Total	1151	100
4 underweight	0) No	10	41.7
	1) Yes	14	58.3
	Total	24	100
Total	0) No	600	35.7
	1) Yes	1083	64.3
	Total	1683	100

Frequency Missing = 41

BMI by F&R₁ ≥ 50%

Table of BMI_pctl_rank by pct_fplgp			
BMI_pctl_rank	pct_fplgp	Frequency	Row Percent
1 obese	1) 50%+	85	34.7
	2) <50%	160	65.3
	Total	245	100
2 overweight	1) 50%+	86	31.4
	2) <50%	188	68.6
	Total	274	100
3 normal	1) 50%+	319	27.0
	2) <50%	861	73.0
	Total	1180	100
4 underweight	1) 50%+	10	40.0
	2) <50%	15	60.0
	Total	25	100
Total	1) 50%+	500	29.0
	2) <50%	1224	71.0
	Total	1724	100

Multivariate Analysis

SAS Proc SURVEYLOGISTIC

- Untreated Caries
 - Analysis of Maximum Likelihood Estimates
 - Odds Ratio Estimates
- Caries Experience
 - Analysis of Maximum Likelihood Estimates
 - Odds Ratio Estimates

Multivariate Analysis: Untreated Caries

Analysis of Maximum Likelihood Estimates						
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	
Intercept	1	-0.2017	1.2345	0.0267	0.8702	
bmi_pctl_rank2 1) Underweight		0.3733	0.2042	3.3426	0.0675	
bmi_pctl_rank2 3) Overweight	1	0.0428	0.1759	0.0593	0.8077	
bmi_pctl_rank2 4) Obese	1	-0.1302	0.4480	0.0845	0.7713	
Sealant on molar 0) No	1	0.4805	0.0811	35.0705	<.0001	
pctl_fplgp 1) 50%+	1	0.2108	0.1164	3.2792	0.0702	
Age	1	-0.1242	0.1331	0.8708	0.3507	
Gender	1	0.0577	0.1371	0.1770	0.6740	
Race / Ethnicity 1) American Indian/ Alaskan Native	1	0.1997	0.3411	0.3425	0.5584	
Race / Ethnicity 2) Asian/Pacific Islander	1	0.0584	0.2968	0.0387	0.8440	
Race / Ethnicity 3) Black/ African American	1	0.2518	0.2446	1.0593	0.3034	
Race / Ethnicity 7) Hispanic White	1	-0.4593	0.2004	5.2501	0.0219	
region 1) Non MSA (Non-Metro)	1	0.2259	0.1228	3.3833	0.0659	

Multivariate Analysis: Untreated Caries

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
bmi_pctl_rank2 1) Underweight vs 2) Normal	1.993	1.108	3.375
bmi_pctl_rank2 3) Overweight vs 2) Normal	1.289	0.946	2.040
bmi_pctl_rank2 4) Obese vs 2) Normal	1.169	0.341	4.005
sm2 0) No vs 1) Yes	2.614	1.902	3.594
pctl_fplgp 1) 50%+ vs 2) <50%	1.524	0.966	2.406
Age	0.883	0.680	1.147
Gender	1.059	0.810	1.386
race 1) American Indian/ Alaskan Native vs 2) Non-Hispanic White	1.284	0.544	3.032
race 2) Asian/Pacific Islander vs 2) Non-Hispanic White	1.115	0.545	2.280
race 3) Black/ African American vs 2) Non-Hispanic White	1.353	0.768	2.383
race 7) Hispanic White vs 2) Non-Hispanic White	0.664	0.420	1.052
region 1) Non MSA (Non-Metro) vs 2) MSA (Metro)	1.571	0.971	2.543

Multivariate Analysis: **Caries Experience**

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.8673	1.1081	0.6127	0.4338
bmi_pct_rank2	1) Underweight	1	0.0499	0.1621	0.0946	0.7584
bmi_pct_rank2	3) Overweight	1	-0.1531	0.1422	1.1594	0.2816
bmi_pct_rank2	4) Obese	1	0.2200	0.3214	0.4686	0.4936
sm2	0) No	1	0.0754	0.0530	2.0233	0.1549
pct_fplgp	1) 50%+	1	0.2989	0.0797	14.0773	0.0002
Age		1	-0.0330	0.1234	0.0716	0.7890
Gender		1	0.0780	0.1167	0.4477	0.5034
race_miss	1) American Indian/ Alaskan Native	1	1.1804	0.3316	12.6759	0.0004
race_miss	2) Asian/Pacific Islander	1	0.2091	0.2511	0.6929	0.4052
race_miss	3) Black/ African American	1	-1.0530	0.2181	23.3105	<0.001
race_miss	7)Hispanic White	1	-0.1265	0.2307	0.3004	0.5836
region	1) Non MSA (Non-Metro)	1	-0.0300	0.0644	0.2168	0.6415

Multivariate Analysis: **Caries Experience**

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
bmi_pct_rank2 1) Underweight vs 2) Normal	1.181	0.801	1.742
bmi_pct_rank2 3) Overweight vs 2) Normal	0.964	0.688	1.352
bmi_pct_rank2 4) Obese vs 2) Normal	1.400	0.607	3.233
sm2 0) No vs 1) Yes	1.163	0.945	1.431
pct_fplgp 1) 50%+ vs 2) <50%	1.818	1.330	2.465
Age	0.968	0.760	1.232
Gender	1.081	0.860	1.359
race_miss 1) American Indian/ Alaskan Native vs 2) Non-Hispanic White	4.017	1.835	8.795
race_miss 2) Asian/Pacific Islander vs 2) Non-Hispanic White	1.521	0.810	2.856
race_miss 3) Black/ African American vs 2) Non-Hispanic White	0.430	0.246	0.752
race_miss 7)Hispanic White vs 2) Non-Hispanic White	1.087	0.700	1.689
region 1) Non MSA (Non-Metro) vs 2) MSA (Metro)	0.942	0.712	1.212

Conclusion 1

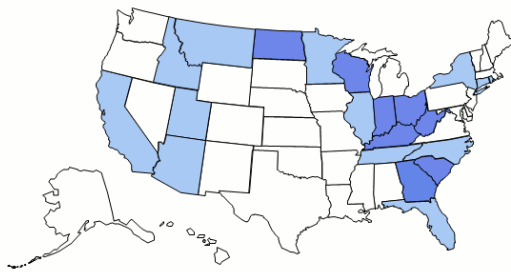
Relationship between BMI & Caries is complex

Conclusion 2

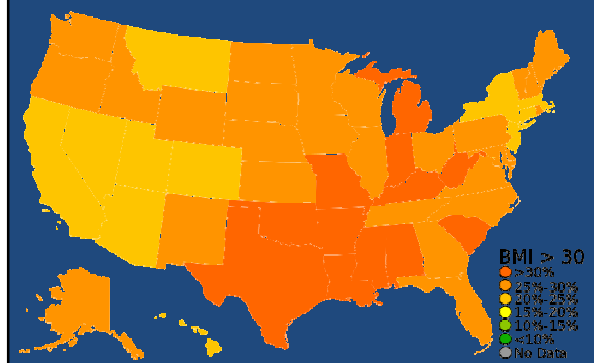
Conducting BMI with BSS is feasible

Obesity Trends* Among U.S. Adults
BRFSS, 1985

(*BMI ≥30, or ~ 30 lbs. overweight for 5' 4" person)



2011



??Conclusions??

Detected inequities should be addressed by targeted prevention/intervention activities with progress measured by similar surveys done at five year intervals.

Prevention and intervention activities may differ depending on the type of disparity being addressed (e.g., regional vs. racial differences).

The data indicate a need to further assess dietary intake along with oral health status.

Dietary intake indicators alone may help in determining patterns of eating associated with risk for dental disease.

Evidence supports the proposal of combined strategies to target both dental caries and obesity simultaneously.

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