

**Vitamin D Intakes & Status among
US Children Aged 1-18 Years:**
*Do Obese and Racially/Ethnically Diverse Youth
Need More Vitamin D?*

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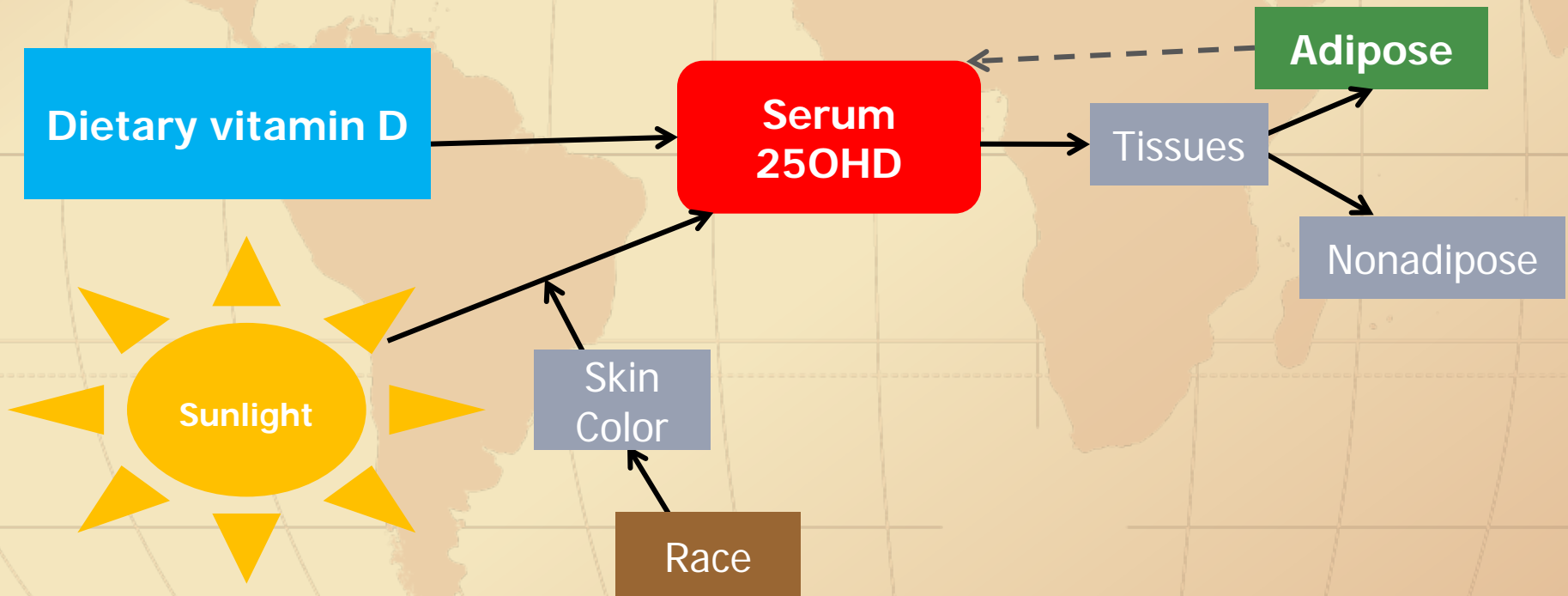


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Background: Vitamin D

- Institute of Medicine identified research needs in vitamin D, particularly in children and amongst racial/ethnic groups



Background: Vitamin D Status

- Low serum vitamin D may be associated with risk factors for several chronic diseases
- Prevalence of vitamin D deficiency is greater among:
 - Obese compared to healthy weight children (50% vs 22%)¹
 - Non-Hispanic (NH) Black compared to NH White children (32% vs 3%)²

¹ Olson et al., *JCEM*, 2011

² Looker et al., *NCHS Data Brief*, 2011

Background: Dietary vitamin D

- Dietary vitamin D intake varies by weight status & race/ethnicity
 - Obese children have lower vitamin D intakes compared to non-obese children (218 IU vs 338 IU)³
 - Mexican American children were most likely to meet or exceed the Adequate Intake (200 IU) compared to NH Black children (69% vs 48%)⁴



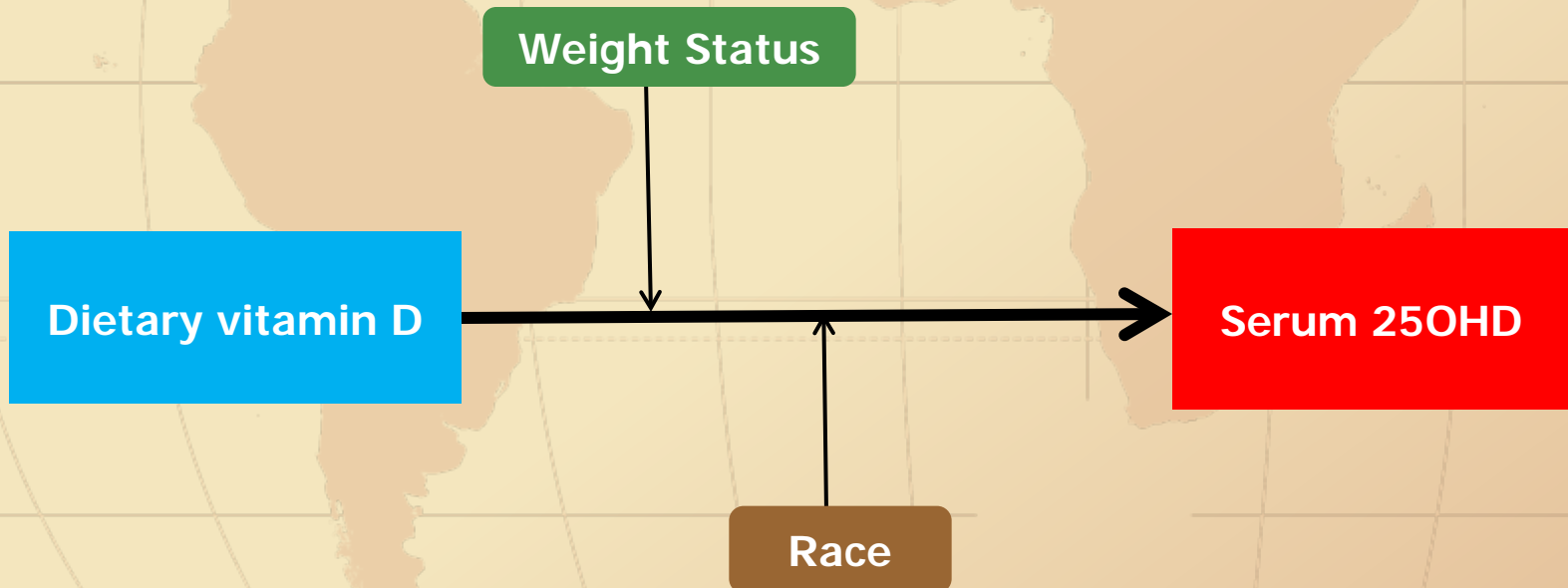
EAR: 400 IU/d

³Rajakumar et al., *Obesity*, 2008

⁴Moore et al., *J Nutr*, 2005

Objective

To examine the influences of **weight status** and **race/ethnicity** on the association between vitamin D intake and serum vitamin D in US children aged 1-18 years



Methods

- 2005-2006 NHANES cross-sectional study of 2,487 children aged 1-18 years
- **SAS** (version 9.2; SAS Ins, Cary, NC)
 - proc surveyfreq, proc surveymeans, proc surveylogistic
- **SUDAAN** (version 10.0; Research Triangle Ins, Research Triangle Park, NC)
 - proc regress
- **Restricted PSU & Strata**

Measurements

Variable	Measurement Tool	Categorization
Serum 25OHD	Radioimmunoassay kit after extraction with acetonitrile (Diasorin, Stillwater, MN)	Dichotomous (inadequate: <20 ng/mL & adequate: ≥20 ng/mL)
Dietary vitamin D	Two 24-h recalls & Dietary Supplement Questionnaire	Dichotomous (EAR*: 0 to <400 IU/day & ≥400 IU/day)
Weight status	Height (stadiometer) & weight (Toledo digital scale); BMIz based on CDC classifications	Dichotomous (healthy weight: BMI <85 th percentile & overweight/obese: BMI ≥85 th percentile)
Race/ethnicity	Computer Assisted Personal Interview (CAPI) Questionnaire	Categorical (NH White, NH Black, Mexican American, Multi-racial/other)

*EAR = Estimated Average Requirement

Measurements

Variable	Measurement Tool	Categorization
<i>Sedentary time</i>	<i>CAPI* Questionnaire</i>	<i>Continuous (hours/day)</i>
<i>SES</i>	<i>CAPI Questionnaire</i>	<i>Categorical (PIR: <130%, 130-350%, ≥350%)</i>
<i>Season</i>	<i>CAPI Questionnaire</i>	<i>Dichotomous (Summer: May 1 – Oct 31 & Winter: Nov 1 – Apr 30)</i>
<i>Latitude</i>	<i>Geocode from Research Data Center (restricted)</i>	<i>Dichotomous (North: ≥35 °N & South: <35 °N)</i>
<i>Other measurements: Age, gender, total dietary energy, total dietary fat, and waist circumference</i>		

*CAPI = Computer Assisted Personal Interview Questionnaire

Dietary vitamin D

- **Total usual dietary vitamin D intake**
 - = usual dietary intake + dietary supplements
 - National Cancer Institute (NCI) method was used to estimate usual dietary vitamin D intake^{5,6}
 - Vitamin D from dietary supplements⁶
- Dichotomized into above/below EAR (400 IU/day)

⁵Tooze et al., *J Am Diet Assoc*, 2006

⁶Bailey et al., *J Nutr*, 2010

Dietary vitamin D and serum 25OHD in US children by vitamin D status; 2005-2006 (n=3310)

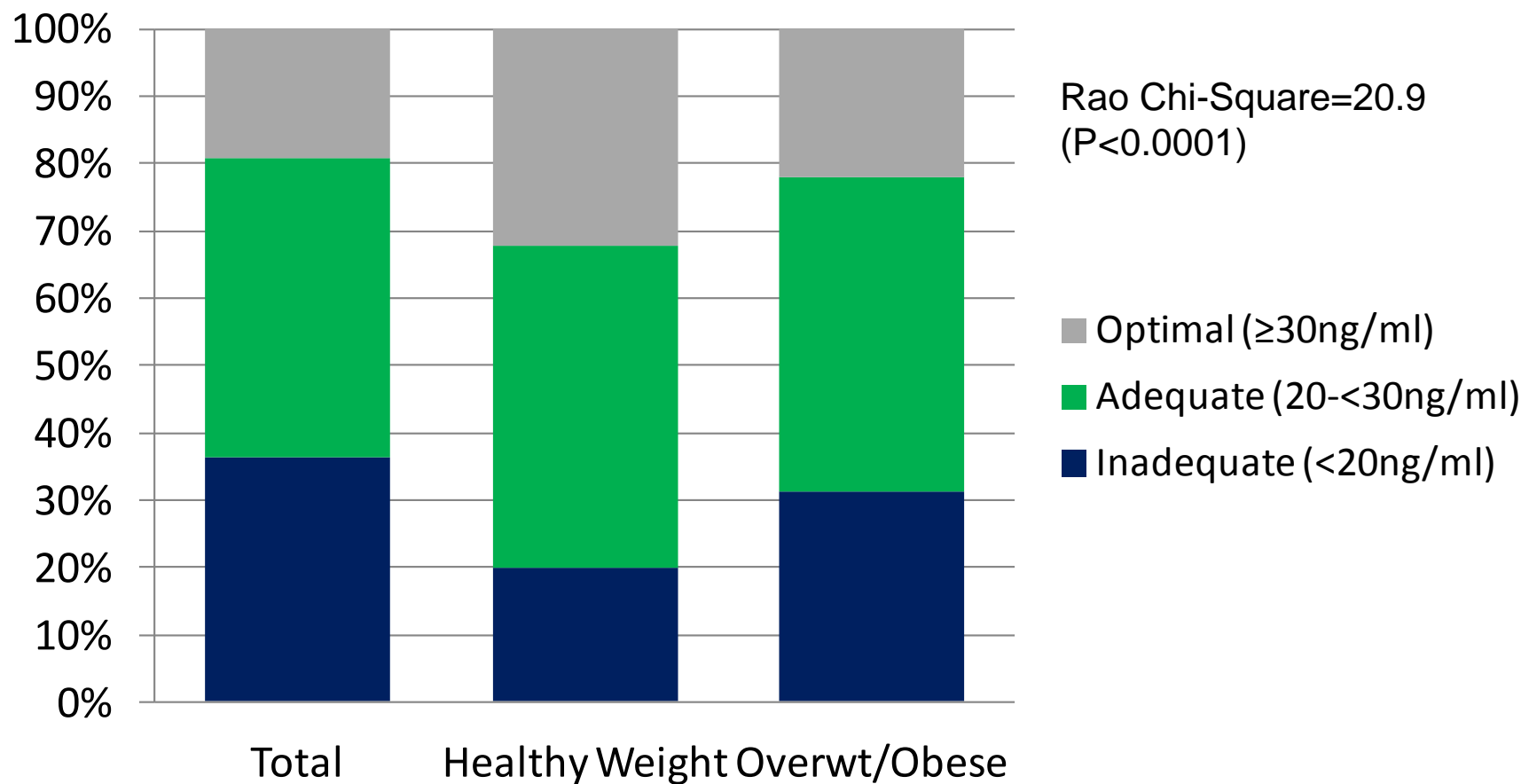
	Total		At risk of inadequacy (<20 ng/ml) [N=1204]		Adequate (20-<30 ng/ml) [N=1463]		Optimal (≥30 ng/ml) [N=643]		P-value ¹
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	
Dietary vitamin D (IU/day)²	281	272-290	213	199-228	298	284-314 ^a	312	288-338 ^a	P<0.0001
25OHD (ng/mL)	26.0	25.5-26.5	14.6	14.3-14.9	25.0	24.7-25.2 ^a	35.8	35.1-36.4 ^a	P<0.0001

¹Analyzed with LSMEANS (SUDAAN)

²Values are geometric mean ± 95% CI dietary vitamin D because of skewed distribution

^aMean is significantly different from at risk of vitamin D inadequacy group, P<0.0001

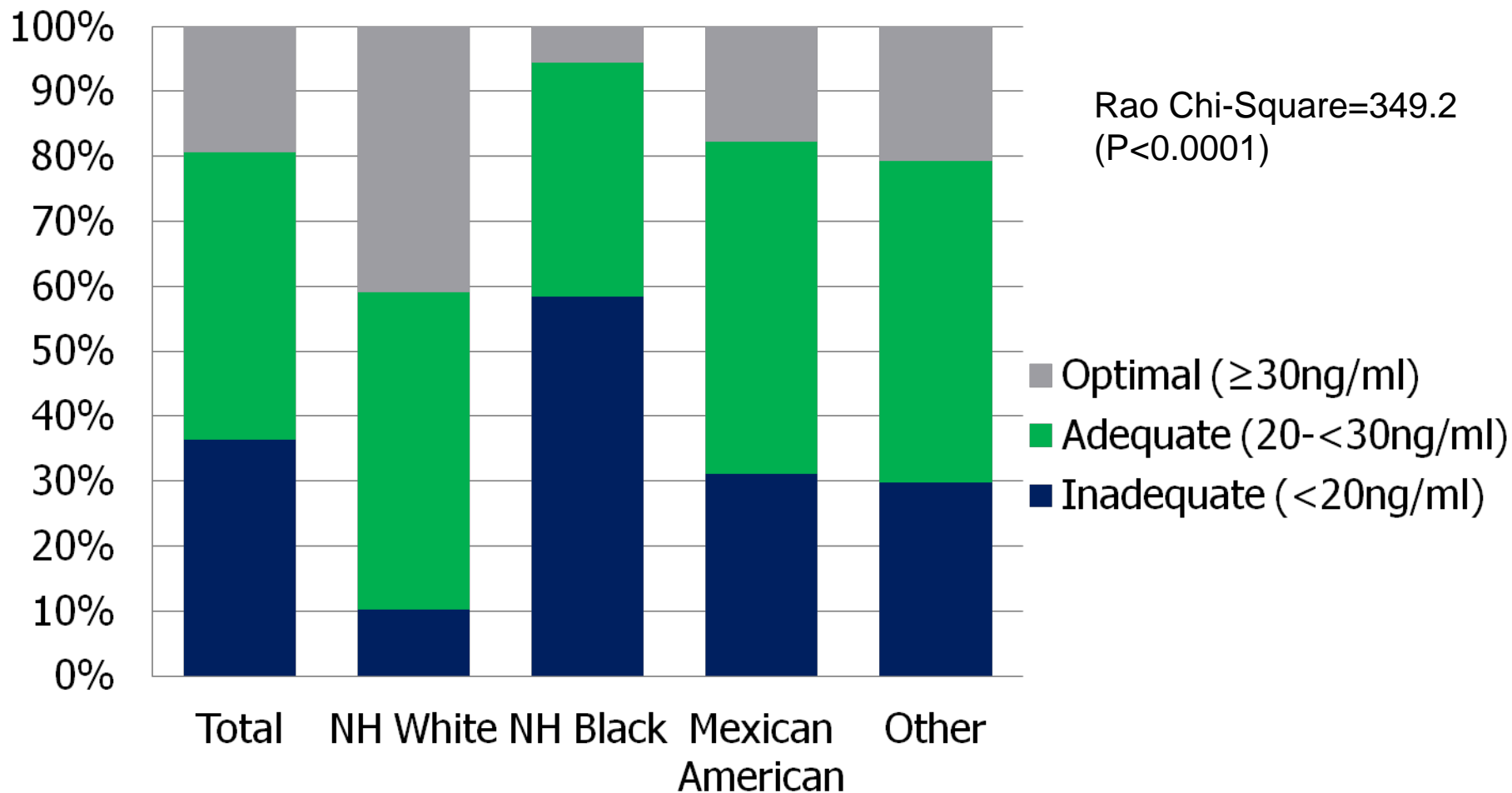
Serum vitamin D in US children aged 1-18 years by weight status; 2005-2006



N (%*):	2789 (100%)	1707 (65%)	1007 (33%)
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*Weighted (excludes underweight)

Serum vitamin D in US children aged 1-18 years by race/ethnicity; 2005-2006



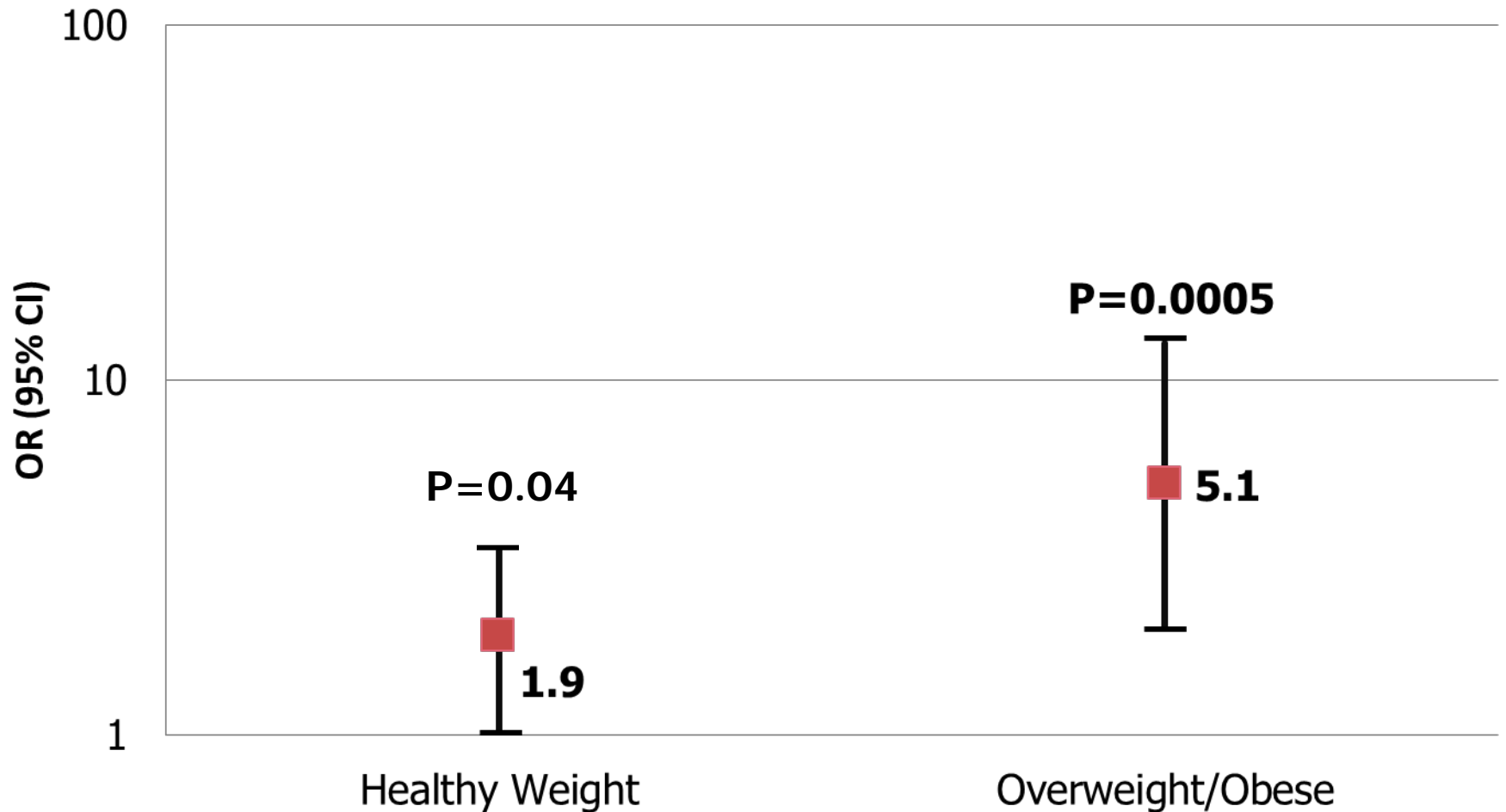
N (%*)	3310 (100%)	908 (61%)	994 (14%)	1107 (14%)	301 (11%)
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*Weighted

Results

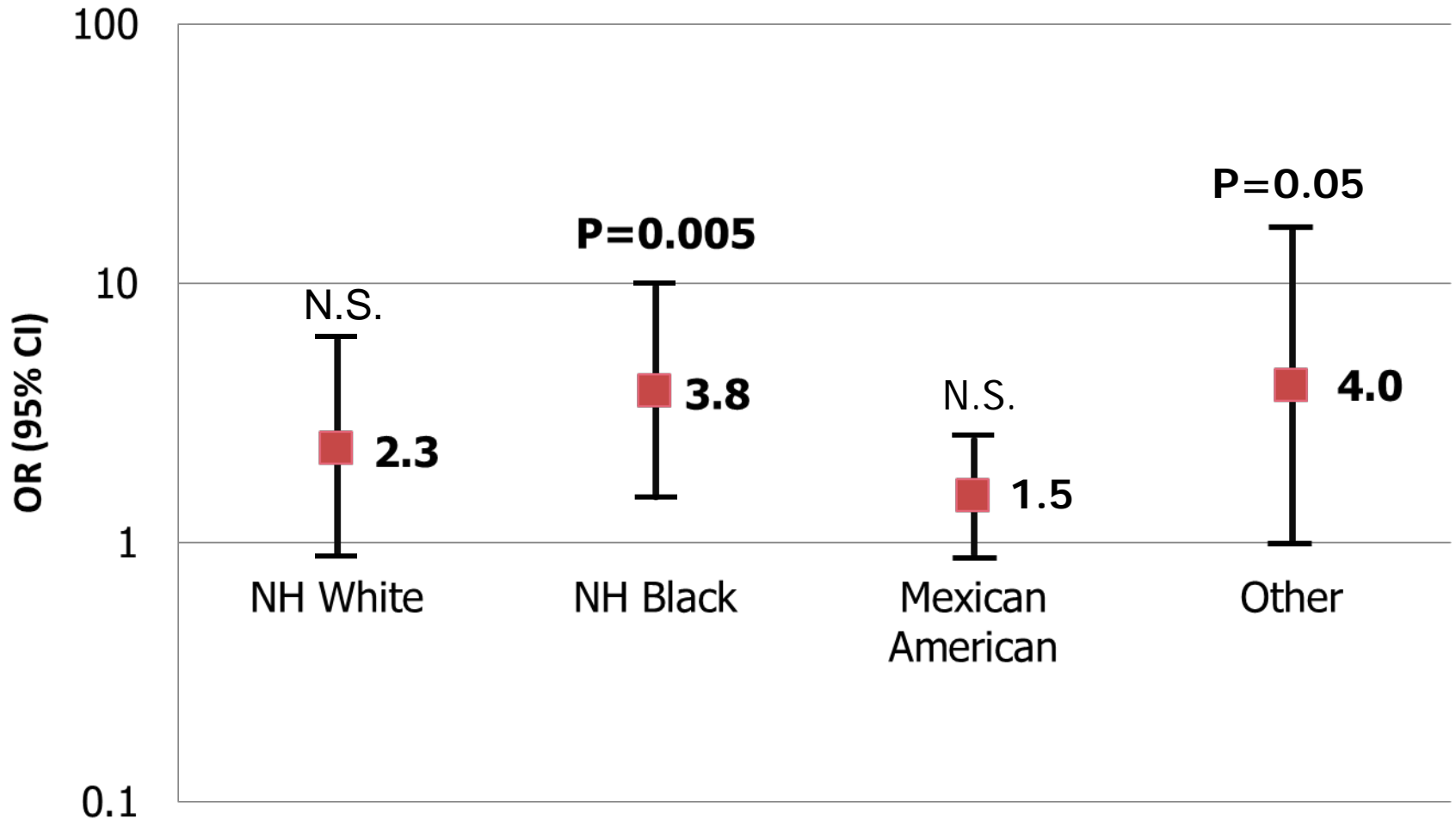
- Children who did not meet the EAR for vitamin D intake were **2.5 times** more likely to have inadequate serum vitamin D than those who met it (95% CI: 1.38-4.46; $P < 0.01$)
- The association between meeting the EAR and vitamin D status was modified by **weight status** ($P = 0.01$) & **race/ethnicity** ($P = 0.02$)

The association between meeting the EAR on the odds of being inadequate in serum 25OHD (<20ng/ml) by weight status*



*Adjusted for age, gender, race/ethnicity, SES, dietary energy, sedentary time, season & latitude

The association between meeting the EAR on the odds of being inadequate in serum 25OHD (<20ng/ml) by race/ethnicity*



*Adjusted analyses

Discussion

- Dietary vitamin D intake was low:
 - 74% failed to meet the EAR of 400 IU/day
- Almost 40% of children had inadequate serum vitamin D levels (<20 ng/ml)
- Fewer than 20% achieved optimal status (≥ 30 ng/ml)

Discussion

- Vitamin D status varied by weight status and race/ethnicity:
 - 21% of healthy weight children were optimal in vitamin D status compared to 7% overweight/obese children ($P < 0.0001$)
 - 25% of NH Whites had optimal vitamin D status, whereas fewer than 1% of NH Blacks achieved this level ($P < 0.0001$)

A faint, light-colored world map is visible in the background of the slide, showing the outlines of continents and a grid of latitude and longitude lines. The map is centered on the Atlantic Ocean.

Strengths:

- Current dietary recommendations
- At-risk populations
- Latitude

Limitations:

- 2-year NHANES cycle
- Estimates of dietary & supplement intake
- Serum 25OHD collection

Conclusions

1. Most children did not meet Dietary Guidelines for vitamin D and few achieved optimal vitamin D status.
2. Overweight/obese and NH Black children are more likely to be inadequate in serum 25OHD when vitamin D intakes are low.
3. Future research examining vitamin D intake recommendations in these at-risk populations is needed.

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Table 1. Selected characteristics by vitamin D status in children ages 1-18 in NHANES 2005-2006 (N=3310)

	Total		At risk of inadequacy (<20 ng/ml) [N=1204]		Adequate (20 - <30 ng/ml) [N=1463]		Optimal (≥ 30 ng/ml) [N=643]		P-value ¹
	N	% (SE)	N	% (SE)	N	% (SE)	N	% (SE)	
Age									
1-8 y	1218	39.5 (1.5)	187	3.7 (0.3)	642	19.1 (1.2)	389	16.7 (1.3)	<0.0001
9-18 y	2092	60.5 (1.5)	1017	18.3 (1.2)	821	28.2 (1.2)	254	14.1 (1.2)	
Sex									
Male	1653	52.2 (1.0)	533	9.6 (0.7)	781	25.2 (1.1)	339	17.5 (1.5)	0.03
Female	1657	47.8 (1.0)	671	12.4 (0.8)	682	22.1 (1.5)	304	13.3 (0.9)	
Race/Ethnicity									
NH White	908	61.2 (1.4)	99	6.2 (1.0)	457	29.9 (1.3)	352	25.1 (1.2)	<0.0001
NH Black	994	14.2 (0.8)	694	8.3 (0.5)	326	5.1 (0.4)	64	0.8 (0.2)	
Mexican American	1107	13.6 (0.6)	405	4.2 (0.3)	534	6.9 (0.4)	168	2.4 (0.2)	
Other	301	11.1 (0.8)	96	3.3 (0.4)	146	5.5 (0.7)	59	2.3 (0.4)	
Weight Status (n=2789)									
Underweight	75	2.6 (0.6)	25	0.7 (0.2)	35	0.8 (0.2)	15	1.2 (0.5) ²	<0.0001
Healthy	1707	64.6 (1.4)	600	13.0 (0.9)	757	30.6 (1.1)	350	21.0 (1.0)	
Overweight	430	15.3 (1.1)	196	4.0 (0.5)	173	7.3 (0.7)	61	4.0 (0.6)	
Obese	577	17.4 (1.2)	314	6.4 (0.7)	216	7.8 (0.8)	47	3.3 (0.8)	
Poverty-income ratio									
$<130\%$	1432	29.9 (1.1)	564	9.3 (0.7)	643	13.7 (0.7)	225	7.0 (0.7)	<0.0001
130% - $<350\%$	1166	38.6 (1.4)	451	7.9 (0.6)	496	19.1 (1.0)	219	11.6 (0.9)	
$\geq 350\%$	712	31.5 (1.8)	189	4.8 (0.7)	324	14.5 (1.0)	199	12.2 (1.2)	
Season (n=3167)									
Winter	1511	47.6 (7.7)	555	10.3 (2.2)	674	23.4 (3.3)	282	13.8 (2.4)	0.33
Summer	1656	52.5 (7.7)	430	11.7 (2.0)	731	24.0 (3.8)	325	16.7 (2.4)	
Latitude									
South	1018	30.9 (4.5)	362	6.2 (1.4)	460	15.7 (1.8)	196	9.0 (1.4)	0.17
North	2292	69.1 (4.5)	842	15.8 (1.4)	1003	31.6 (2.3)	447	21.7 (1.9)	

¹Analyzed with Rao-Scott Chi-square test

²The relative SE is $>30\%$; this estimate is unreliable

Table 2. Serum 25OHD, anthropometrics, dietary intake, and sedentary time by vitamin D status in children ages 1-18 in NHANES 2005-2006 (N=3310)

	Total		At risk of inadequacy (<20 ng/ml) [N=1204]		Adequate (20-<30 ng/ml) [N=1463]		Optimal (≥30 ng/ml) [N=643]		P-value ¹
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	
25OHD (ng/mL)	26.0	25.5-26.5	14.6	14.3-14.9	25.0	24.7-25.2 ^a	35.8	35.1-36.4 ^a	P<0.0001
Height (cm), (n=3108)	143	141-145	153	151-155	143	140-145 ^a	136	132-140 ^a	P<0.0001
Weight (kg), (n=3300)	43.9	42.4-45.4	57.1	52.6-61.5	43.2	40.6-45.8 ^a	35.6	32.1-39.0 ^a	P<0.0001
Waist Circumference (cm), (n=3082)²	68.0	67.4-69.1	76.1	73.4-78.9	68.0	66.5-69.5 ^a	63.1	60.9-65.6 ^a	P<0.0001
Total dietary vitamin D (IU/day)²	281	272-290	213	199-228	298	284-314^a	312	288-338^a	P<0.0001
Total dietary energy (kcal/day)²	1,861	1,821-1,905	1,837	1,773-1,904	1,893	1,824-1,963	1,834	1,770-1,900	P<0.0001
Total fat (g/day)²	67.6	65.7-69.7	67.7	65.1-70.4	68.2	64.9-71.7	66.9	64.2-69.8	P<0.0001
Sedentary time (hrs/day) (n=3131)	1.3	1.3-1.4	1.7	1.5-1.9	1.4	1.3-1.5 ^b	1.0	0.9-1.2 ^a	P<0.0001

¹Analyzed with LSMEANS (SUDAAN)

²Values are geometric mean \pm 95% CI for waist circumference, dietary vitamin D, dietary energy and dietary fat because of skewed distribution. Need to exp (logged mean) to get geometric mean; exp (logged 95% CI) to get transformed 95% CI

^aMean is significantly different from at risk of vitamin D inadequacy group, P<0.0001

^bMean is significantly different from at risk of vitamin D inadequacy group, P<0.001