Association of Acrylamide hemoglobin biomarkers with obesity, abdominal obesity and overweight in general US population: NHANES 2003-2006

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OUTLINE

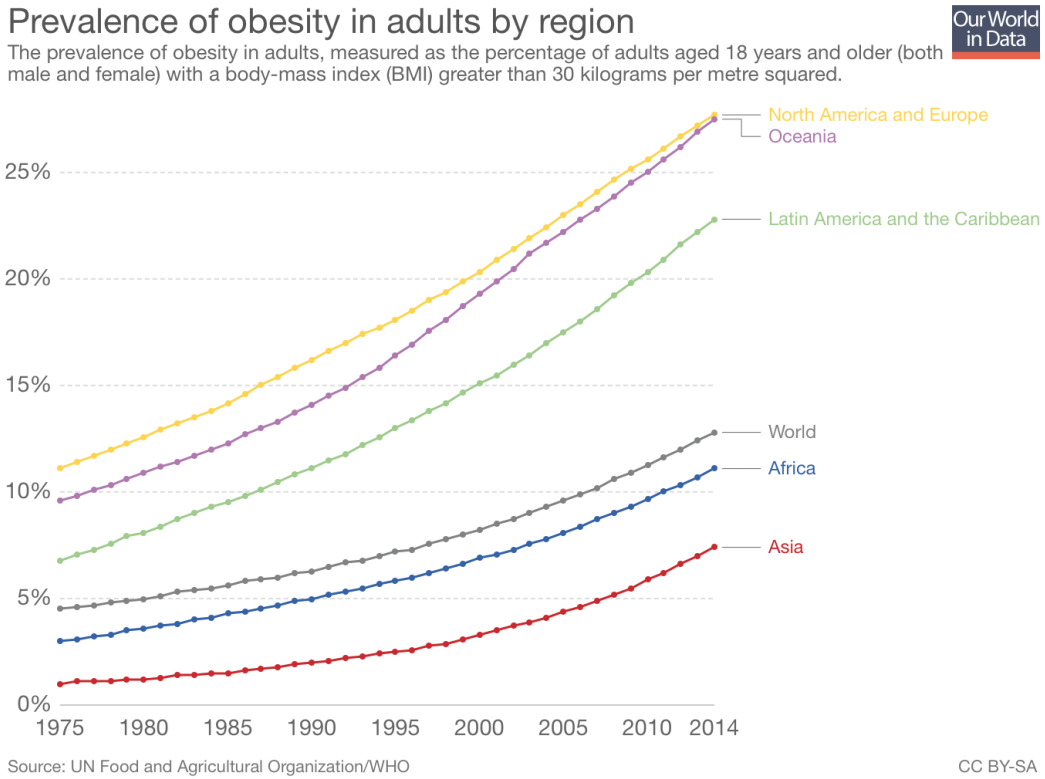
1. Introduction
2. Methods
3. Results
4. Discussion & Critique

INTRODUCTION

1

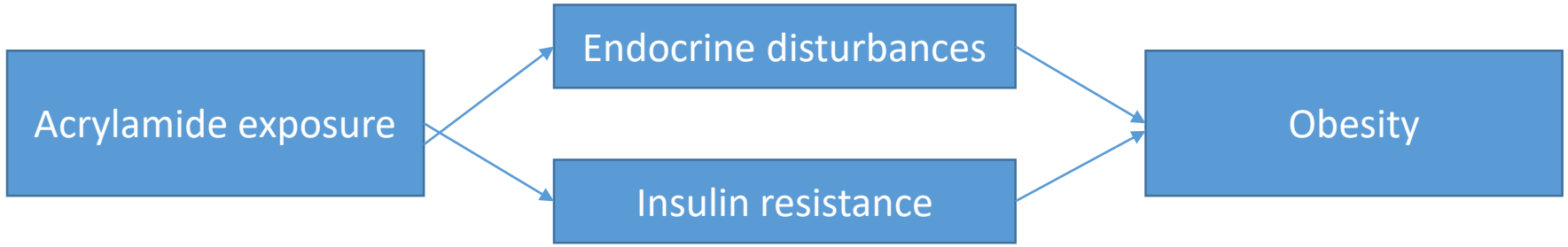
Introduction

- Obesity (global pandemic), associated with increased risk of morbidity and mortality
- Common causes (excess caloric consumption and sedentary lifestyle), cannot explain obesity epidemic
- There is need to explore other “unconventional risk factors”



Introduction

- Sources of Acrylamide (AA):
  - Food consumption
  - Skin contact
  - Occupational inhalation
  - Tobacco smoking
- Previous epidemiological research (general population):



- Hypothesis: **Long-term exposure to AA is associated with obesity-related outcomes (including abdominal obesity and overweight)**

METHODS

2

Study Design

- The National Health and Nutrition Survey (NHANES) (2003-2006)
  - Administered by National Center for Health Statistics (NCHS)
  - “Continuously monitor the nutrition and health status of general US population.”
  - Cross sectional, every 2 years.
  - Multistage cluster and stratified probability, nationally representative.

- Study Inclusion Criteria
  - Individuals aged 20-85 years who participated in NHANES.
  - Individuals with no missing data related to body mass index (BMI), waist circumference, or hemoglobin adduct levels of AA (HbAA & HbGA)

N=8,364

Dependent Variables

General and Abdominal Obesity

- General obesity
  - body mass index (BMI) (fig 1)
  - 3 categorical outcomes
  - 25.0≤ BMI <30 = **overweight**
  - BMI ≥ 30 = **obese**

$$BMI = \frac{\text{weight (kg)}}{\text{height}^2\ (\text{m}^2)}$$

Figure 1. Formula to calculate body mass index (in metric)

- Abdominal obesity
  - Waist circumference (WC)
  - Measured to the nearest 0.1 cm at the high point of the right iliac crest (fig 2) (at minimal respiration)
  - Two categorical outcomes
  - WC >102 cm in men or WC > 88 cm in women = **abdominal obesity**

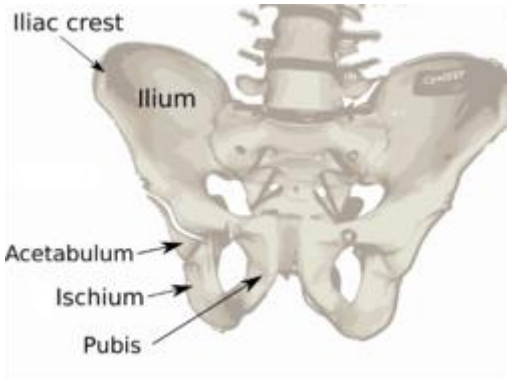


Figure 2. Skeletal position of the iliac crest, used to measure waist circumference.

Independent Variables

Hemoglobin Adduct Levels & Sample Demographics

- Hemoglobin Adduct Levels
  - HbAA and HbGA (fig. 3)
  - Spot blood samples
  - Adducts extracted and examined using high-performance liquid chromatography tandem mass spectrometry.
  - Limits of detection within 3 and 4 pmol/g
  - Each sample measured in duplicate to minimize error
- Sociodemographic factors and characteristics
  - Age, gender, race/ethnicity
  - Life factors (e.g. marital status, education, income, etc.)
  - Health factors (e.g. energy in-take, smoking status, etc.)

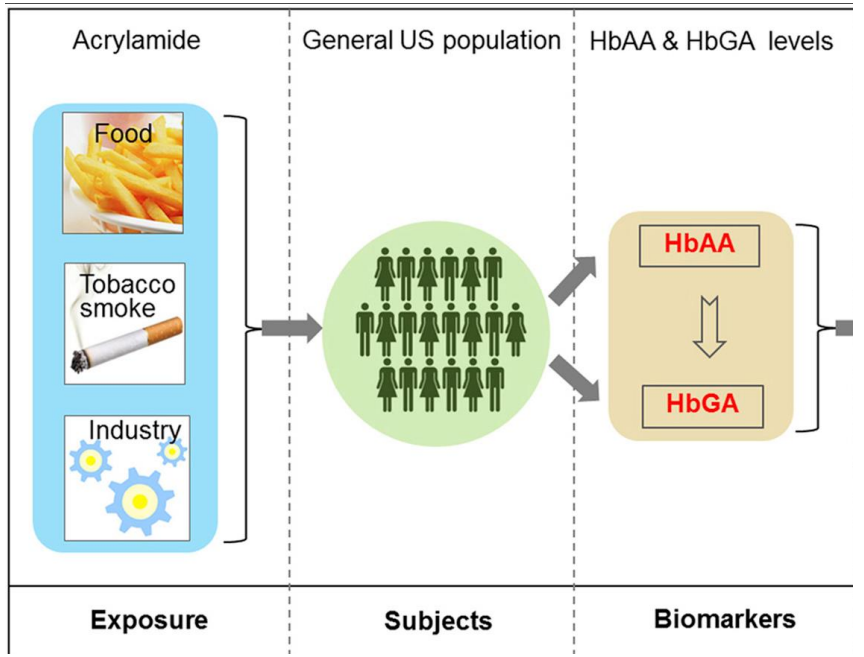
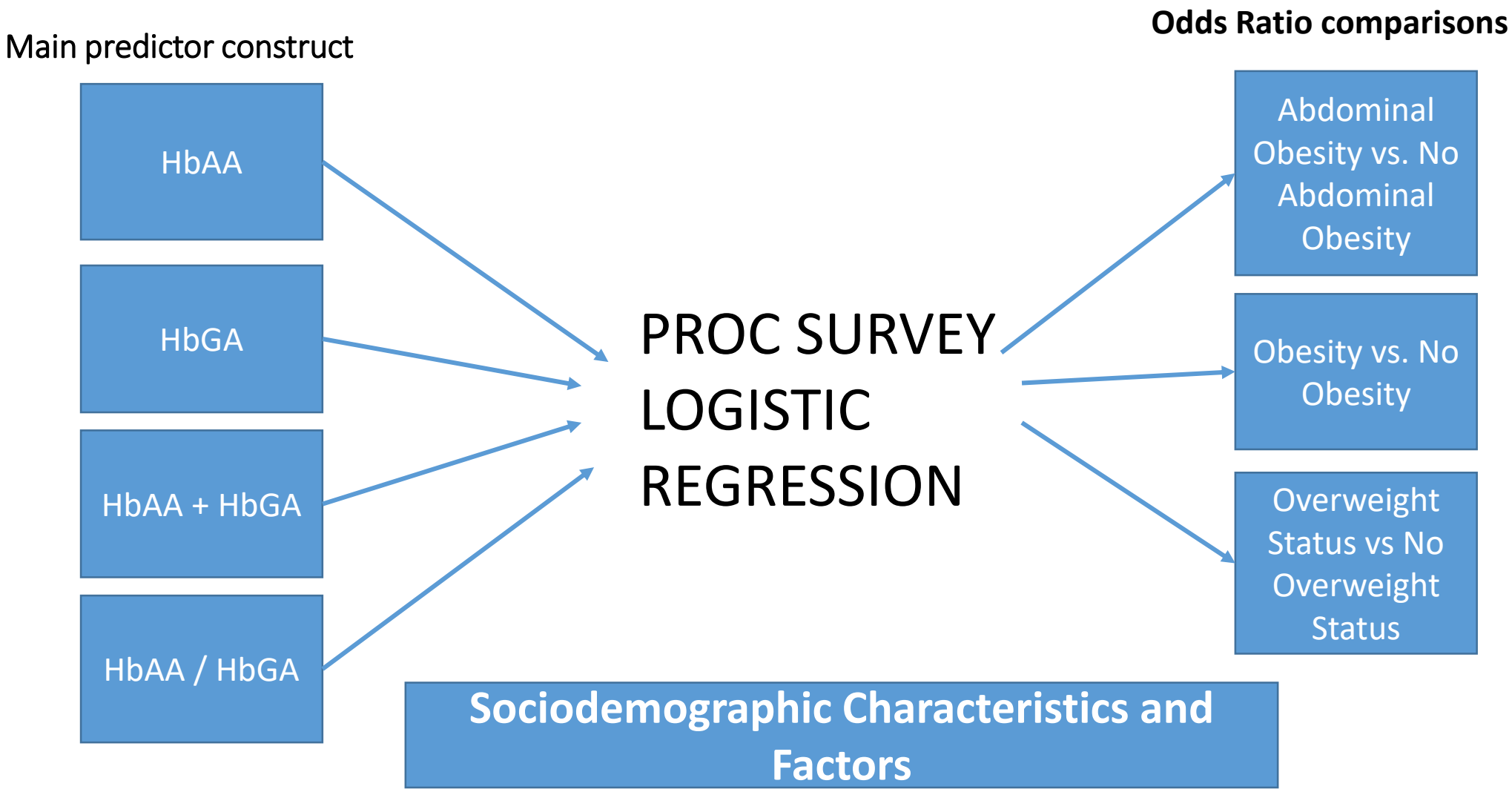


Figure 3. Detecting acrylamide from HbAA & HbGA

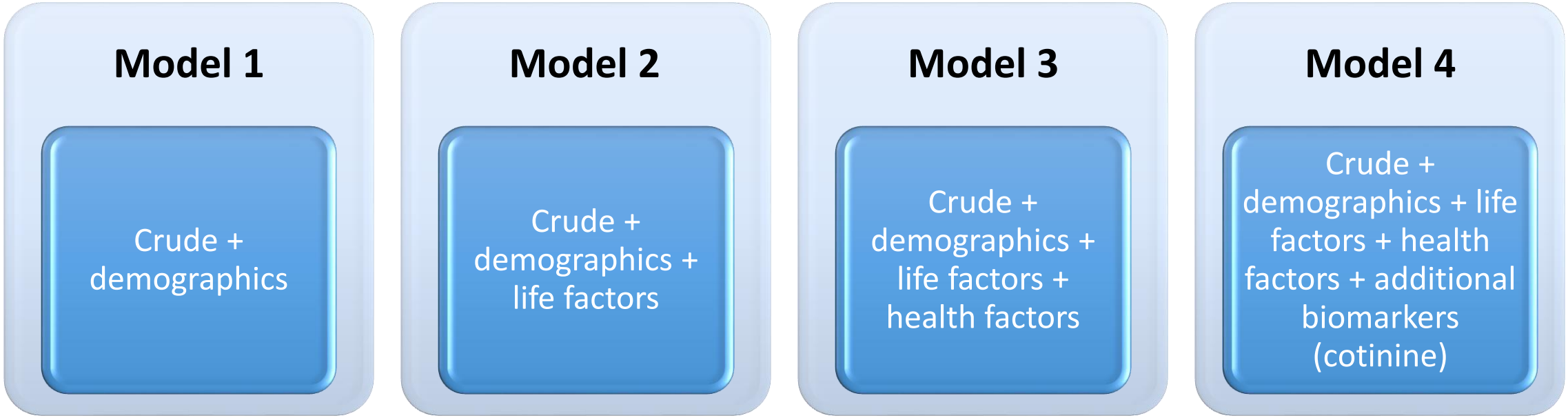
Statistical Analysis



Logistic Regression Assumptions

- Outcome is binary - obese or not, overweight or not, abdominal obesity or not
- Independent observations – cross sectional with no repeated measures
- Little or no multicollinearity between independent variables – forward step model construction and assessing effect size.
- Linearity in the logit with continuous variables – see above
- Large sample size – N>50 + (8 X the number of independent variables) N>8,000

Statistical Analysis – Model Construction



- Missing covariate values substituted with sample medians.
- Significance of model interactions assessed with likelihood-ratio tests
- Additional analysis removed outliers of main predictors (>99% or <1%)
- Significance all two-tailed and reported at alpha=0.05
- Confounders identified by >10% change in beta for main effects.

RESULTS

3

Characteristics of the study population

- N = 8364
- Aged between 20 and 85 years from NHANES 2003 – 2006
- **Male:** 48.2% and **Female:**51.8%
- **Non-Hispanic white:** 51.8% , **non-Hispanic black:** 20.4%, **Mexican:** 20.7%, **Other races:** 7.1%
- 33.99% → obesity
- 56.11% → abdominal obesity
- 52.87% → overweight

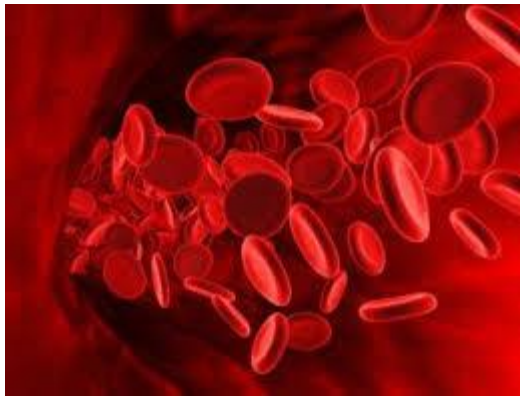
AA hemoglobin biomarkers and obesity

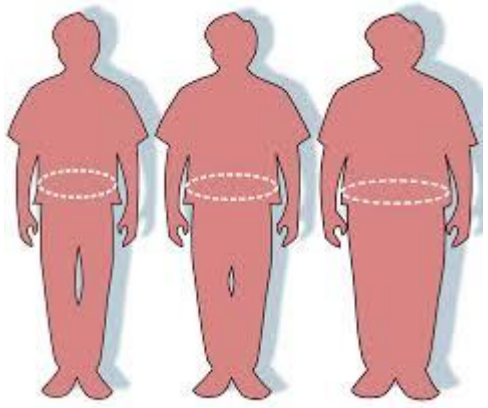
- HbAA (pmol/g Hb) ↑ → probability of obesity ↑
- HbGA/ HbAA ↓ → probability of obesity↑

Significant across 4 models:
P-values < 0.001

- HbGA
- HbAA + HbGA (pmol/g Hb)

Not consistent significance,
P-values varies across 4 models





Subgroup and sensitivity analysis

- Age (<40 or >= 40 years)
- Gender
- Race/Ethnicity
- Education levels
- Marriage

- Family PIR
- Energy intake
- Physical activity
- Smoking status
- Alcohol
- History of hypertension

HbGA/HbAA & obesity: consistent in all subgroup analyses

Except for non-Hispanic black and Mexican American subgroups

DISCUSSION & CRITIQUE

4

Main Findings and Study Implications

- HbGA, HbGA/HbAA were positively associated with obesity, abdominal obesity, and overweight while controlling for select confounders
- HbAA was inversely associated with obesity-related outcomes after adjusting for select confounders
- Study findings have implications for public health
- The study findings can be generalizable given the nationally representative data source, and the wide age range (20-85 years)

Strengths

- Use of rigorous statistical analysis
  (4 statistical models, sensitivity & sub-group analysis)

- Uses a nationally representative data
  - Relatively large sample size

- Detailed overview of the existing body of knowledge

- Combines BMI and WC

Limitations

- Authors did not clearly delineate what obesity related outcomes (problem in measurement- overlap in measurement)

- Given the cross-sectional nature of the data, the we cannot truly determine the long-time effect of acrylamide

- Some residual confounders were not accounted for

  (e.g occupation)

- HbGA & HbAA (multicollinearity)

Conclusion

- The study found an association between internal exposure to AA with obesity, abdominal obesity and overweight among study participants

- The authors recommend that future prospective studies should examine the association between AA exposures and obesity to further confirm the study findings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