High meat high protein diet: Problems of weight gain and obesity

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Introduction

- Obesity is a growing epidemic (*WHO statistics*)
- Of the 22 industrialized countries in the world, the U.S. has the highest obesity – roughly one-third obese and two-third overweight *(Sassi, 2009)*
- Health care spending per capita in the U.S. for obese adults is 38 percent higher than for adults of normal weight *(Congressional Budget office report, Sept. 8, 2010)*.

Genetics and obesity

- Researchers argue that genetic defects can only explain a small portion of the obesity epidemic, forcing us to look for behavioral explanations to obesity *(Maes et al., 1997; Stunkard et al., 1990)*
  - Genetic pre-disposition of an individual can only influence the metabolic efficiency, but it cannot determine the actual metabolism of the body, which is impacted by the environmental factors such as lack of physical activities and poor diet (*Parks et al., 2013).*

Poor eating habits and obesity

- Studies have associated the rise in obesity in the U.S. with an increase in calorie intake from snacking (Cutler et al., 2003) and from larger portion sizes (Rozin, et al., 2003).

- Another stream of literature has focused on dietary fat, especially from meat, which for a long time had been considered as the primary dietary determinant of obesity (Hill, 2000; Willett, 1998).
  - Warnings from American Heart Association regarding risks from saturated fat has led Americans to switch to eating more lean meat (Daniel et al., 2011).
  - Over the last two decades the reported percentages of dietary energy derived from fat has fallen; but interestingly obesity has continued to increase (Willett, 1998).

Rising meat consumption and obesity

- Besides rising obesity, another trend that has emerged in the US over the last five decades is the rising meat consumption *(USDA report).*
- Total boneless meat consumption (red meat, poultry, fish)

  1950 = 138 pounds per person per year

  2000 = 195 pounds per person per year

  2012 = 220 pounds per person per year
- On average Americans are consuming 9.6 ounces of meat per day (2012) against the recommended amount of 3-4 ounces per day.

Rising meat consumption and obesity

- The two rising trends, namely, rising obesity levels and rising meat consumption suggest that there is a statistical correlation between the two variables.
  - Is this relationship spurious or causal?
- Lack of consistent results:
  - A number of studies have observed the prevalence of overweight and obesity is higher among meat eaters as compared to vegetarians *(Wang and Beydoun, 2009).*
  - Another study that reviewed 30 observational studies found no consistent associations between obesity and meat consumption *(Togo et al., 2001).*
- Besides a lack of agreement, the existing studies do not offer a conceptual model to explain '*WHY*' meat consumption increases the susceptibility to obesity.

Why has meat consumption risen?

- In the U.S. there is a fear and confusion about protein deficiency. There is a dominant belief that a high meat diet is essential for preventing protein deficiency *(Allen, 2014)*.

- Americans are consuming much higher levels of both meat and proteins compared to the recommended amounts.

	Recommended	Actual Consumption
Protein per day for Men	56 grams	102 grams
Protein per day for Women	46 grams	70 grams
Meat consumption per day	3-4 ounces	9.6 ounces

Source: NHANE Survey for protein; USDA survey for meat consumption

- 70% of protein in the average American diet comes from meat.

Protein intake and body weight

- A few studies examined the metabolism of protein and concluded that high protein diet helps maintain healthy body weight *(Latner & Schwartz, 1999; Barkeling et al., 1990).*
- 5 major flaws in the experimental design of these studies:
  - Studies not randomized and hence the findings cannot be generalized.
  - Assume all people included in the experiments have similar metabolism - no control is maintained for different body types.
  - Do not control for the tastes of the food types to provide high and low protein - food tastes can impact hunger and accordingly lead to greater or lesser quantities of food consumption *(Drewnowski, 1997).*
  - Do not control the source of protein -- animal versus plant protein, which tend to have different digestive properties.
  - These studies are restricted to short term impact of protein consumption on satiety and cannot comment on the long term impact of protein consumption on body weight.

Protein intake and body weight

- A comprehensive survey of the literature lead Anderson and Moore (2004) to conclude, "Protein source, as a factor affecting the short term feeding response of humans, has received little investigation and the results are mixed" (p. 976).
- Therefore, the perception that a high protein and high meat diet helps in maintaining healthy body weight may be market driven because the scientific evidence does NOT confirm this view.
- More research is required to examine the relationship between protein consumption coming from different sources and maintaining healthy body weight over long term.
- **Our study will examine this relationship further.**

Research Questions

- The two broad questions that will be examined are:
  - **Research Question 1:** Metabolically, does high meat consumption provide us with a miss-matched source of energy that puts us at a higher risk of obesity?
  - **Research Question 2:** Behaviorally, does high meat consumption lead to irregular eating habits that puts us at a higher risk of obesity?
- This study will identify the intervening variables to help explain '*WHY*' high meat consumption makes an individual more vulnerable to overweight and obesity.

Digestion of animal vs plant protein

- Studies have found that plant protein is typically encased in cellulose cell wall that is harder to break and hence takes longer to digest *(Young and Pellet, 1994).*

- The dietary fiber contained in the plant foods is “resistant to digestion by human digestive enzymes” *(Anderson et al., 2009),* which increases the digestion time of plant protein as compared to meat protein that has no dietary fiber *(Newby, 2009).*

- The animal protein requires higher acidic environment for digestion, which is found in the human stomach (low pH level). Therefore, logically animal protein should digest faster than plant protein in the human digestive tract.

- The above notion was substantiated in a lab-experiment on rats that have similar digestive system as humans *(Gupta, Dakroury, and Harper, 1957; Geiger, 1951).*

Hypothesis Development

Hypothesis 1: Faster energy is released from the digestion of animal-protein as compared to the plant-protein in the human digestive tract.

Research Protocol: For testing hypothesis-1, an *invitro* model was constructed to examine the digestibility of plant and animal protein in human digestive system.

Laboratory Experiments

- Positive control test (using BSA – all protein)
- Negative control test (using lab grade dextrose – no protein)
- Full experiment conducted on 8 food items



Preparation



Homogenizing



Strained Extract



Centrifuge



Visualization



Samples for Spectrophotometer



Spectrophotometer

Laboratory Procedure

Food item + Distilled water

↓

Homogenize and strain

↓

Centrifuge, take supernatant fluid

↓

Incubator (2 hrs, 37 degree Celsius)

Control	Control + pH 2	Control+ pH 2+pepsin	Control + pH 5.4	Control + pH5. 4+pepsin	Control + pH 8	Control + pH8+trypsin

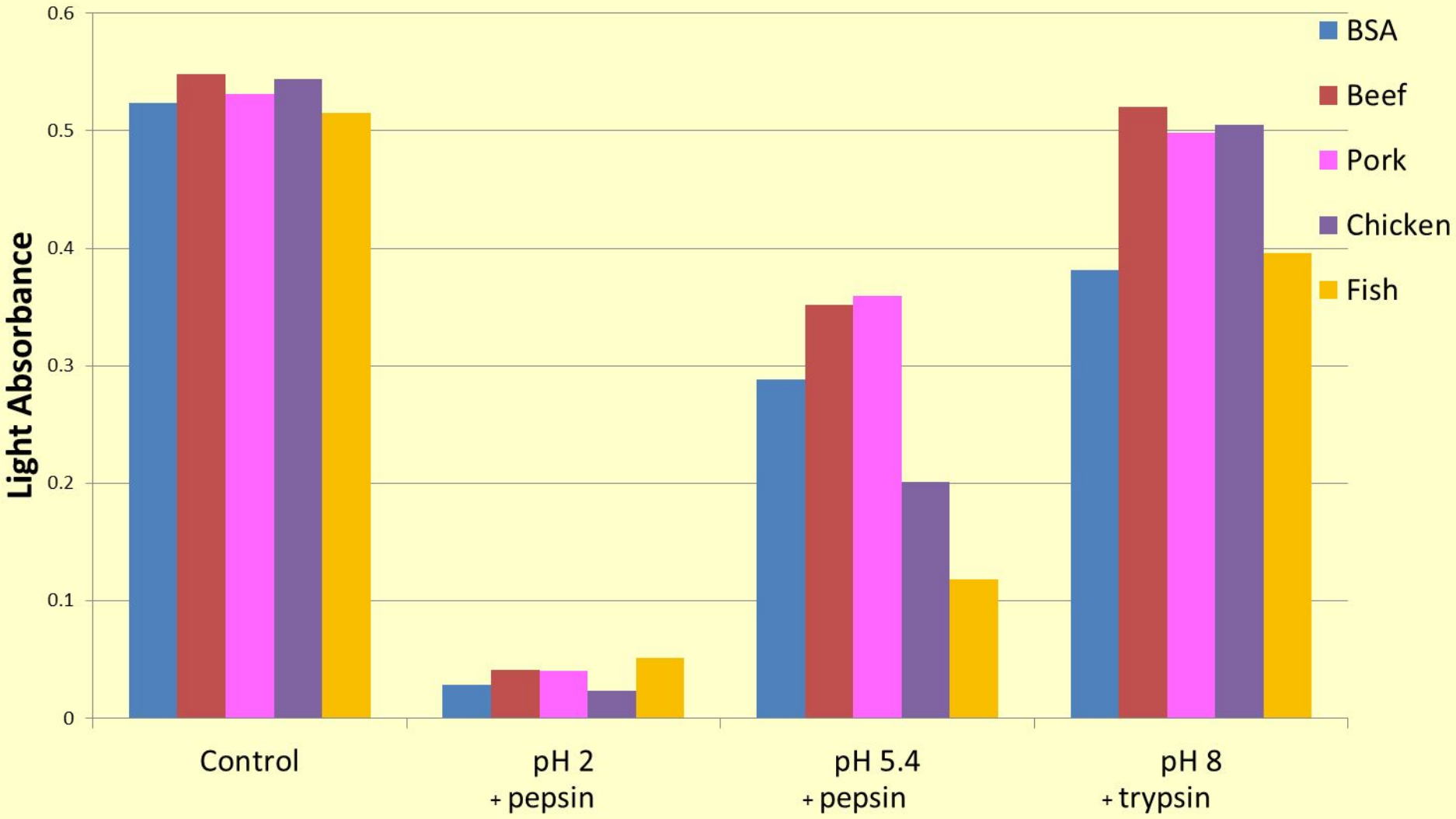
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3 samples were taken, Biuret reagent added and vortexed

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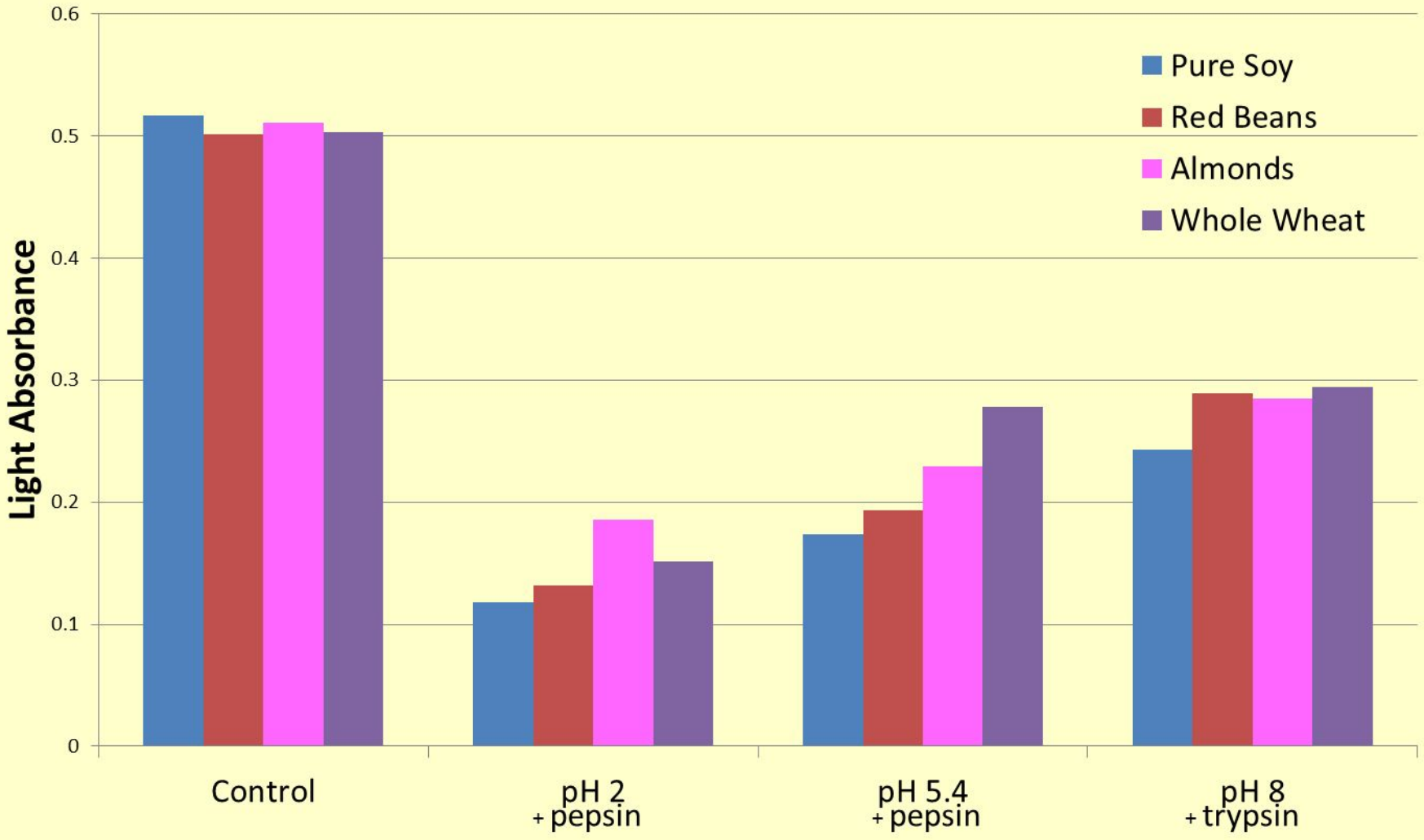
spectrophotometer reading

Light Absorbance Results for Animal Protein



Lower Light Absorbance Indicates Greater Protein Digestion

Light Absorbance Results for Plant Protein



Lower Light Absorbance Indicates Greater Protein Digestion

Support for Hypothesis 1

- The lab results show that most of the animal protein gets digested in the human stomach – releasing energy faster. While, digestion of plant protein takes place at an even rate in the stomach and the duodenum – releasing energy slower.

Logical Question further explored in the study:

- ➢ Does faster release of energy from high meat-diet provide a miss-matched source of energy if you have a sedentary lifestyle?
- ➢ Since animal protein digests faster, does it make people consuming high meat-diet hungry faster, leading them to overeat and/or snack frequently?

Meat – a miss-matched source of energy

- The calorie usage depends on the metabolism rate, which is different for different people depending on their gender, age, and body composition.
  - Higher physical activity builds greater muscle mass, which increases an individual's metabolic rate, demanding more energy.
  - To sustain a sedentary lifestyle one needs small steady doses of energy that can be provided by a diet that digests slowly – which our experiment shows are more plant-based.
  - The average American lifestyle has become more sedentary due to the developments in modern technology *(Caballero, 2007).*
- To stay healthy, what adjustments have Americans made in their dietary patterns to suit their changing lifestyle?
- **NONE**; on the contrary Americans are now consuming more meat as compared to five decades back.

Meat – a miss-matched source of energy

- High meat-diet tends to digest faster thus releasing higher amounts of energy in shorter period of time *(Howarth et al. 2001)*. Plant-based foods have high-fiber and lower energy density and take longer to eat and digest *(Haber et al., 1977)*. The results were confirmed in our lab-experiments.
  - The calories that are unused are stored as body-fat no matter what the source maybe *(Allen, 2014).*
  - When the body feels energy deficit, instead of burning the stored fat to recover the energy; it is retrieved from sugar in the blood.
  - As the sugar levels drop, the body sends a signal of hunger *(Mayer, 1955)* and typically an individual resorts to snacking.
  - Over a period of time these individuals may develop a learned behavior coaxing them to eat bigger meals to prolong the hunger pangs – thus consuming greater calories, that is, overeating.

Meat – a miss-matched source of energy

- This happens because burning body-fat to release energy requires the body to be in an overdrive situation, implying involvement in at-least moderate form of physical activity that sedentary lifestyle does not provide.
- Calling it energy imbalance, Bray (1987) provides a detailed explanation of how through peptides found in the gut and the brain this process leads to excess fat storage.

Hypothesis Development

- **Hypothesis 2:** People consuming higher meat proportions in their diet are more likely to snack.
- **Hypothesis 3**: People consuming higher meat proportions in their diet are more likely to overeat.

Meat consumption & biological rhythms

- The period of hunger and satiety is controlled by hypothalamus that communicates with the tissues in the gastrointestinal tract (GIT) via bidirectional neuronal and humoral pathways *(Konturek et al., 2011; Arble et al., 2009).*
- Due to the interlocking transcriptional feedback loops any problem in GIT (such as irregular bowel movement, constipation, and irritable bowel syndrome) can disrupt the biological cycle of daily food intake making them irregular.
- One of the primary reasons for irregular bowel movement, constipation, and irritable bowel syndrome is a diet low in fiber *(Dwyer, 1988; Dennison et al., 2005; Pickett-Blakely 2014).*
  - Data from NHANES 1999-2010 study shows the average intake of fiber in the US is **half** of the prescribed amount *(Anderson et al., 2009)* because American diet contains high proportion of meat, which has no fiber.

Meat consumption & biological rhythms

- Americans who are predominantly meat-eaters are at a higher risk of constipation compared to vegetarians *(Dwyer, 1988; Sanjoaquin et al., 2004).*
  - It can be argued that not experiencing the bowel movement in the morning hours after waking up will make these individuals feel full, which will make them more likely to skip breakfast or eat a very light breakfast.
  - Similarly, due to uncertainty of bowel movement lunch will also become irregular. Either they will skip lunch or eat lighter lunch.
  - Since they have not eaten a proper meal through the day, they will suffer from external cues of hunger reflecting less control on hunger. In other words, they will want to snack when they see or smell food, and they are more prone to snacking on energy dense food.
  - Dinner becomes their main meal where they get most calories.

Meat consumption & biological rhythms

- On the other hand, individuals with regular bowel movements will be regulated by biological rhythms of eating a full breakfast.
- They will regularly eat lunch, which will be their main meal because it is oriented towards mainly catabolic processes during the daytime.
- Such individuals will demonstrate more control on their eating habits and will be guided by internal cues of hunger; they will eat snacks at scheduled times.

Hypothesis Development

Hypothesis 4: High meat-eaters are more likely to:

a. skip breakfast
b. skip lunch
c. snack when they see or smell food (external cues) - reflecting less control on eating habits
d. snack on energy dense processed food
e. make dinner as their bigger (main) meal

Hypothesis 5: Vegetarians are more likely to:

f. regularly eat breakfast
¨ regularly eat lunch
¨ snack at scheduled times – reflecting more control on their eating habits
a. snack on vegetables and food items that are **not** energy dense
b. make lunch as their bigger (main) meal.

Eating Behavior & Obesity

- Consumption of larger and irregular meals was associated with greater risk of obesity compared with a more-frequent regular pattern of eating *(Fabry & Tepperman, 1970).*
- Obesity was associated with skipping breakfast (Morgan et al., 1986) and high frequency of eating in the form of snacking *(Basdevant et al., 1993; Cutler et al., 2003).*
- Obese people consumed a greater proportion of energy intake in the latter half of the day compared with lean individuals *(Baecke et al., 1983; Bellisle et al., 1997).*
- Irregular and infrequent meal eating leads to ***adaptive hyperlipogenesis***, whereby the body's utilization of ingested food changes in the direction of increasing stores of energy (as fat) as though to fortify against future shortages *(Wooley et al., 1979; Farshchi, 2004).*

Physical Exercise and Obesity

- Physical activity helps develop muscle tissues, which are metabolically more active compared to fat thus raising the metabolic level of the body that helps in losing weight.
- Decreased physical activity is associated with the developments in modern technology that have eased and/or reduced the physical work in an average individual's daily work life *(Caballero, 2007).*
- Tremblay and Willms (2003) found that physical activity was negatively correlated with overweight and obesity in children; while watching TV and playing video games was positively correlated with overweight and obesity in children.

Hypothesis Development

Hypothesis 6: People who have higher meat consumption are more likely to be overweight.

Hypothesis 7: People who are physically inactive are more likely to be overweight.

Field Study

- Designed a questionnaire to gather information on peoples' eating habits and behaviors.
- Administered in 4 Midwestern towns – Macomb (IL), Cedar Rapids (IA), Ames (IA), Fairfield (IA)
- 625 surveys were given out of which 537 received back, giving us a 86% response rate
- 31 surveys not usable; giving us a sample size of 506.
- 17 outliers dropped, giving us 489 usable data points

Analyzed the data using SPSS 10.1.

Field study results: Support for hypothesis 2 and 3

- *People consuming higher meat proportions in their diet had a higher tendency to snack frequently (correlation = 0.188; $p \leq 0.002$)* - **Hypothesis 2 supported.**
- *People consuming higher meat proportions in their diet had a higher tendency to overeat (correlation = 0.149; $p \leq 0.01$)* - **Hypothesis 3 supported.**

The above results show that people who have higher meat consumption tend to snack frequently and tend to overeat, which are likely causes of obesity.

Support for hypothesis 4

People who had higher meat consumption:

- had a higher tendency to skip their breakfast *(correlation = 0.152; $p \leq 0.001$)* – ***supports hypothesis-4a***.
- had a higher tendency to skip their lunch *(correlation = 0.182; $p \leq 0.001$)* – ***supports hypothesis-4b***.
- had a higher tendency to snack when they saw or smelled food *(correlation = 0.098; $p \leq 0.030$)*– ***supports hypothesis-4c***.
- had a higher tendency to snack on processed & energy dense food items *(correlation = 0.321; $p \leq 0.001$)* – ***supports hypothesis-4d***.
- had a higher tendency to make dinner as their bigger meal *(correlation = 0.353; $p \leq 0.001$)* – ***supports hypothesis-4e***.

Support for hypothesis 5

People who were vegetarians:

- had a higher tendency to regularly eat their breakfast *(correlation = 0.226; $p \leq 0.001$)* – ***supports hypothesis-5a***.
- had a higher tendency to regularly eat their lunch *(correlation = 0.273; $p \leq 0.001$)* – ***supports hypothesis-5b***.
- had a higher tendency to snack at regular times *(correlation = 0.098; $p \leq 0.040$)* – ***supports hypothesis-5c***.
- had a higher tendency to snack on vegetables, fruits, simple snacks *(correlation = 0.289; $p \leq 0.001$)* – ***supports hypothesis-5d***.
- had a higher tendency to make lunch as their bigger meal *(correlation = 0.430; $p < 0.001$)* – ***supports hypothesis-5e***.

Support for hypothesis 6 & 7

Variables	Standardized Coefficients of the Independent Variables
Dependent ⇒ Independent ⇓	Body mass index
Meat consumption	**0.404*** ($p \leq 0.0001$)
Recreational physical exercise	**- 0.180*** ($p \leq 0.0001$)
Physical labor at workplace	- 0.029 ($p \leq 0.510$)
F-statistic R-squared N	**34.014** ($p \leq 0.0001$) 0.175 489

The regression results show that body mass index (BMI) is positively impacted by higher meat consumption and negatively impacted by higher recreational physical exercise.

Conclusions

- **Metabolically**, high meat diet digests faster
  - that provides a rapid release of energy, which when not used converts to fat – increasing our risk of obesity
  - that makes us hungry faster leading us to snack frequently and/or overeat – increasing our risk of obesity.
- **Behaviorally**, high meat diet adversely changes our eating habits making them irregular, which increases our risk of obesity.

High meat consumption and lack of exercise were found to be significantly associated with increase in obesity.

Recommendations to reduce obesity

- Our study supports the notion that eating a balanced diet is important for maintaining healthy weight.
- Both vegetarian and non-vegetarian diets can be healthy if they are balanced using scientific nutrition principles to match the level of activities in our day-to-day lifestyle.
- A sedentary lifestyle that most American support needs a change in the diet from 70% animal protein to a diet that has 70% plant protein.
- Eating habits and tastes are formed at young age and are harder to change during later years. Therefore, we need to focus on educating children at young age about their food choices and the impact it will have on their personal health.

Contribution to theory development

- Our research contributes to theory development by identifying the intervening variables to help clarify '*WHY*' high proportions of meat consumption leads to obesity; a question that was not be answered by earlier observational studies.

- By identifying the intervening variables, this paper advances causality between meat consumption and obesity, which could not be claimed from earlier observational studies.

Contribution to other areas

- The results of our study may be useful for epigenetic scholars – an important question for them to explore is how high meat consumption may be changing the genetic predisposition of an individual towards obesity.
- Our research also provides the missing link to another research stream that examines the relationship between obesity and the chronic bowel problems but is tentative about the direction of causality. Our research supports the notion that high meat diets (providing low fiber) cause IBS and irregularity, which causes obesity – thus providing the directional clarity between IBS and obesity.

Limitations & Future Research

Limitations

- The field study data was collected from four mid-west towns, hence the results cannot be generalized to the entire population of the U.S.
- Self reported data; social desirability to under-report data on weight, which actually strengthens the findings.
- Impact of sugar and fatty foods was not included in our study.
- Use of cross-sectional data, therefore causal inferences cannot be implied.

Future Research

- Collect field study data from other parts of the U.S to increase the generalizability of our findings
- Conduct controlled group experiments to examine the impact of higher animal-protein on obesity.

Acknowledgements

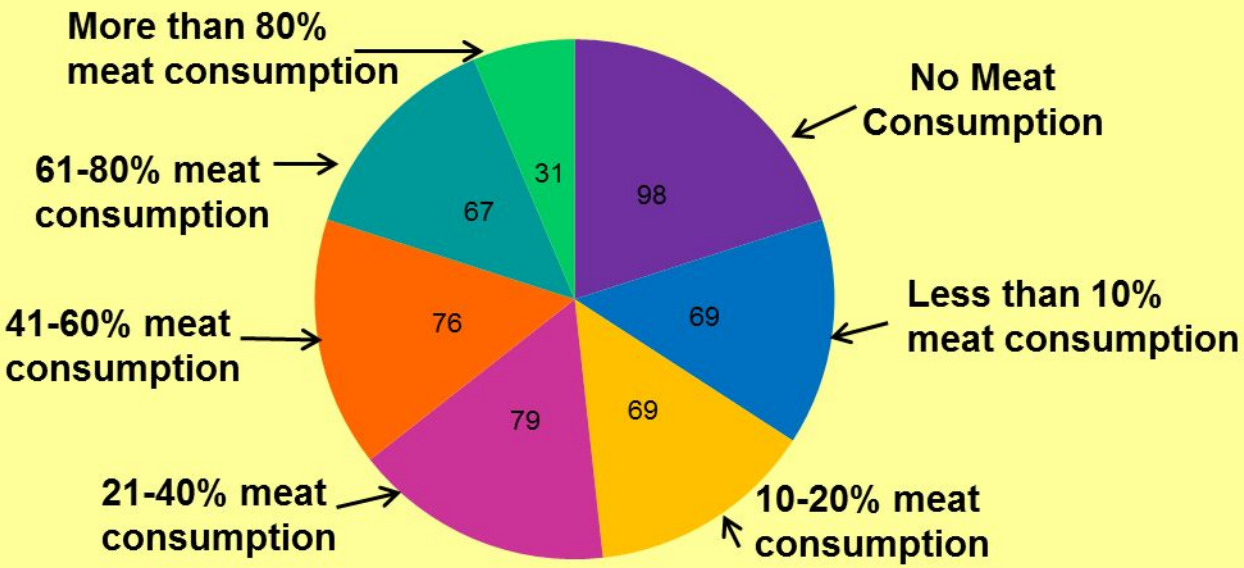
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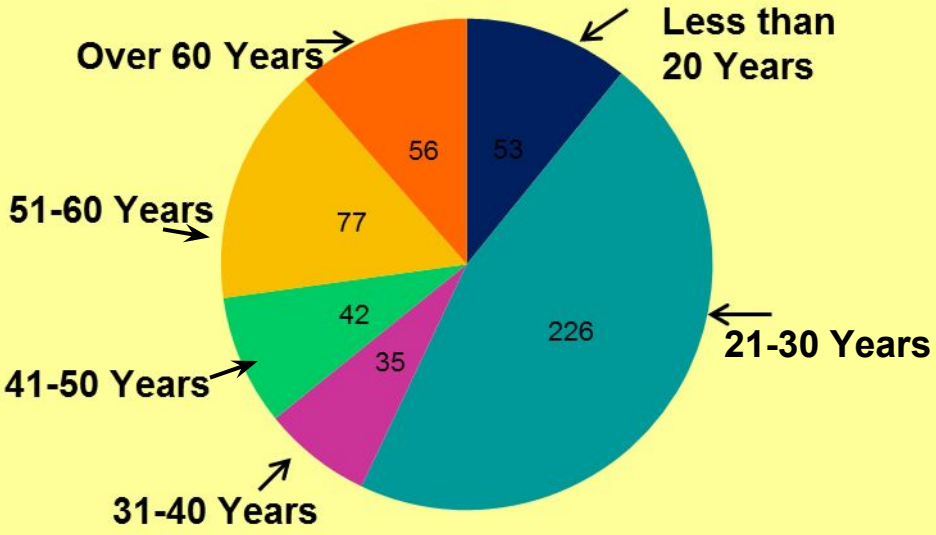
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Meat Consumption Scale



Number of Respondents by Age



Gender

