

Sex differences in Obesity and Responses to Obesity treatment

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Glossary of common abbreviations

Adipo1	Adiponectin receptor 1
Adipo2	Adiponectin receptor 2
AES	Australian eating survey
AGHE	Australian Guide to Healthy Eating
AgRP	Agouti-related peptide
AMDR	Acceptable Macronutrient Distribution Range
BMI	Body mass index
BMR	Basal metabolic rate
CCK	Cholecystokinin
cm	Centimetre
CNS	Central nervous system
CONSORT	Consolidated Standards of Reporting Trials
CRP	C-Reactive protein
CVD	Cardiovascular disease
DASH	Dietary approaches to stop hypertension
EDTA	Ethylene-diamine-tetra-acetic acid
FM	Fat mass
GHS-R	Growth hormone secretagogue receptor
GLP-1	Glucagon-like peptide 1
GLP-2	Glucagon-like peptide 2
IL-6	Interleukin-6
HDL	High-density lipoprotein
HMW	High-molecular weight
HP	High protein

JAK-STAT3	Janus kinase/signal transducers and activators of transcription-3
Kg	Kilogram
kJ	Kilojoule
lb	Pound
LBM	Lean body mass
LDL	Low-density lipoprotein
LepR- β	Leptin receptor beta
LMW	Low molecular weight
LP	Low protein
NRV	Nutrient reference value
OECD	Organisation for economic cooperation and development
PA	Physical activity
PI3K	Phosphoinositide 3-kinase
PPAR	Peroxisome proliferator-activated receptors
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PYY	Peptide YY
RCT	Randomised controlled trial
SP	Standard protein
TE	Total energy
TG	Triglycerides
TNF- α	Tumor necrosis factor-alpha

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SYNOPSIS

The prevalence of obesity and obesity related chronic diseases are still a major health concern and poor dietary intake is a large contributor. Sex differences may predispose an individual to becoming overweight or obese or may determine how individuals respond to lifestyle interventions. Research is needed that increases our understanding of how sex modifies the development and treatment of overweight and obesity. Therefore, intervention impacts need to be tested, and their effectiveness established, separately for males and females. This thesis aims to investigate sex differences in obesity, in particular, differences in weight loss success, dietary approaches to weight loss and physiological factors associated with weight loss and dietary intake, namely the appetite and energy homeostasis regulating hormones leptin, ghrelin and adiponectin.

A systematic review was conducted to determine whether the effectiveness of weight loss interventions is the same for males and females and if not, which interventions are better suited to each of the sexes. Overall, males lost more absolute weight than females, however females were still successful. Few differences in weight loss were found when differences in baseline weight were accounted for. Analysis of effect sizes found small differences in weight loss favouring men for both diet and diet plus exercise interventions. There is little evidence from this review to indicate that men and women should adopt different weight loss strategies. Current evidence supports moderate energy restriction in combination with exercise for weight loss in both men and women.

The next study investigated sex differences in self-selected dietary intakes of fruits and vegetables, fat, and energy-dense, nutrient-poor foods during a weight loss intervention. Dietary intake was assessed using the Australian Eating Survey and fasting blood was collected to assess plasma carotenoids and fatty acids. There was little change in fruit or vegetable intakes during weight loss, although men tended to increase fruit intakes. Males and females significantly reduced their intakes of fat (g) and energy-dense, nutrient-poor foods during weight loss, however their intakes of energy-dense,

nutrient-poor foods were still 35% of total energy intake during weight loss. Males had better correlations between fruit and vegetable intakes and plasma carotenoid concentrations than females. There were few correlations between dietary fatty acids intake and RBC membrane fatty acids. Fruit and vegetable and fat intakes during weight loss appear to predict weight loss for males but not females.

The next study investigated the association between baseline energy homeostasis and appetite regulating hormones and weight loss success in males and females. Females had significantly higher baseline concentrations of leptin, adiponectin and unacylated ghrelin as well as ratios of leptin:adiponectin and leptin:ghrelin. The ratio of acylated:unacylated ghrelin was significantly higher in males. In males and females, a higher baseline concentration of unacylated ghrelin predicted greater weight loss at six months. Additionally in females, higher baseline total ghrelin predicted greater weight loss and a higher ratio of leptin:ghrelin predicted weight gain at six months. Further investigation is required into what combinations and concentrations of these hormones are optimal for weight loss success.

Investigating whether particular nutrients or dietary patterns can alter hormone concentrations may reveal an important link that could help in the development of more effective weight loss strategies. Concentrations of leptin, adiponectin and ghrelin were measured at baseline of a weight loss intervention and habitual dietary intake was assessed in the six months prior. Associations between usual dietary intake and hormone concentrations were more common in females than males. It appears that a diet higher in fruits and vegetables and lower in energy-dense, nutrient-poor foods may have a more favourable effect on appetite in females, however further research is required that investigates the influence of usual dietary intake on hormone concentrations in both males and females, particularly in relation to weight change.

This thesis has identified a number of key areas that should be considered in future studies in order to progress this area of research. Further research needs to be conducted under real world conditions to elucidate which dietary strategies are preferred and adopted by males and females attempting weight loss and whether

these strategies are in fact effective for weight loss and maintenance. To determine if there is a true difference in weight loss success between males and females, interventions should report weight loss as a percentage of baseline weight. Any future research investigating the relationship between dietary intake and appetite and energy homeostasis regulating hormones needs to control for sex differences in these hormones, and also needs to identify mis-reporters and potentially exclude them from the analysis. Identification of the dietary preferences of males and females during weight loss and any lifestyle interventions that can favourably alter hormone concentrations for both males and females has the potential to change the way current weight loss advice is provided.