

## Background/Briefs for Clinicians on Obesity and Health Impacts

This document identifies and provides (or links to) papers and fact sheets that provide clinical staff with an overview of how obesity affects individuals' general and reproductive health.

### **Straight Talk about Obesity and Health**

<http://www.prevent.org/images/stories/Files/publications/Obesity%20Impact-v2.pdf>

This reader-friendly fact sheet provides an overview of the scope, and health and economic impacts of the overweight/obesity epidemic that affects individuals, families, communities, employers and the overall health system in the United States.

### **Dietary Guidelines for Americans 2005**

<http://www.health.gov/dietaryguidelines/dga2005/document/>

Based on peer-reviewed scientific studies, the Guidelines provide information about diet, physical activity and other issues related to what we should eat, and how much physical activity we need.

### **Promoting Healthy Weight Among Women of Reproductive Age, January 2006**

<http://www.amchp.org/aboutamchp/publications/web/healthy%20weight/promoting-healthy-weight.php>

This paper reviews factors that influence healthy weight, demographics of obesity among women of reproductive age, the impact of overweight/obesity on perinatal outcomes, and community-based prevention strategies that can help women maintain healthy weight.

### **Aim for a Healthy Weight Education Kit**

[http://www.nhlbi.nih.gov/health/heart/obesity/aim\\_kit/index.htm](http://www.nhlbi.nih.gov/health/heart/obesity/aim_kit/index.htm)

This kit provides information on how to implement an effective weight management program in an office or clinic. Available for a nominal fee, it includes a quick-reference card on steps to effective patient weight management, a pocket-size waist circumference measure, customizable patient weight profile sheets, reproducible patient handouts, and references for studies analyzing overweight/obesity identification, evaluation and treatment. Health professionals can view kit components free of charge Online that feature information on how to initiate a weight management discussion with patients, tips for weight loss success and clinical guidelines on managing adult overweight/obesity.

### **Roadmaps for Clinical Practice Series: Assessment and Management of Adult Obesity**

<http://www.ama-assn.org/ama/pub/category/10931.html>

The Series consists of 10 booklets for health professionals offering recommendations on how to address adult obesity in the primary care setting. Of particular interest is Booklet 3, a primer that educates primary care physicians about providing medical care to overweight and obese adults. It covers topics such as patient readiness and making treatment decisions. It also provides patient scenarios for self-evaluation, and a continuing medical education (CME) component.

### **BMI: Body Mass Index: What Does This All Mean?**



BMI..What Does All  
This Mean.doc

This quick guide provides an overview of what body mass index (BMI) is, how to calculate it for adults and children, and why measurements differ for children and teens.

### **Overweight and Obesity: Research and Implication for Reproductive Health**



obesity &  
reproductive hith resr

This white paper provides health professionals with an overview of how overweight and obesity intersect with reproductive health. It examines what is known and not known about the effects of obesity on reproductive health for women and men.

The above list of resources were identified and compiled by  
the Region III Reproductive Health, Overweight and Obesity Work Group.

## BMI - Body Mass Index: What Does This All Mean?

**So you have calculated BMI and found which weight category BMI matches. What does this all mean?**

Definitions of overweight have varied widely and there has not been a simple uniform definition. Numerous publications based on the recommendations of expert committees have struggled with developing working definitions of weight status. These recommendations have evolved from weight-for-height standards to sex specific population-dependent references. The most recent transition is a movement toward a single body mass index (BMI; in kg/square meter) standard that is applicable to all adults. Because it is ***independent of age and reference population***, BMI can be used for comparisons across studies both in the United States and internationally.

**BMI is not the only indicator of health risk.**

BMI is just one of many factors related to developing a chronic disease (such as heart disease, cancer, or diabetes). Other factors that may be important to look at when assessing risk for chronic disease include:

- Diet
- Physical Activity
- Waist Circumference
- Blood Pressure
- Blood Sugar Level
- Cholesterol Level
- Family History of disease

## BMI for Adults

Body Mass Index or BMI is a tool for indicating weight status in adults.<sup>1</sup> It is a measure of weight for height. For adults over 20 years old, BMI falls into one of these categories:

| BMI            | Weight Status |
|----------------|---------------|
| Below 18.5     | Underweight   |
| 18.5 – 24.9    | Normal        |
| 25.0 – 29.9    | Overweight    |
| 30.0 and Above | Obese         |

Note: [BMI for Children and Teens](#) is based on gender and age specific charts. Discussed in a later section.

Webpage for BMI for Children and Teens: <http://www.cdc.gov/nccdphp/dnpa/bmi/index.htm>

BMI *correlates* with body fat. The relation between fatness and BMI differs with age and gender. For example, women are more likely to have a higher percent of body fat than men for the same BMI. On average, older people may have more body fat than younger adults with the same BMI.<sup>2</sup>

For more information about overweight among adults, see *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. Bethesda, MD: NHLBI, 1998. This resource is available as a pdf in color or black and white online at: <http://www.nhlbi.nih.gov/guidelines/obesity/practgde.htm> . There are a number of copy ready patient handouts included in the appendix.

### **How does BMI relate to health?**

The BMI ranges are based on the effect body weight has on disease and death.<sup>3</sup> As BMI increases, the risk for some disease increases. Some common conditions related to overweight and obesity include<sup>4</sup>

- Premature death
- Cardiovascular disease
- High blood pressure
- Osteoarthritis
- Some cancers
- Diabetes

BMI is only one of many factors used to predict risk for disease. BMI cannot be used to tell a person if he/she has a disease such as diabetes or cancer. It is important to remember that weight is only one factor that is related to disease.

This is a good reminder that BMI is only one piece of a person's health profile. It is important to talk with your doctor about other measures and risk factors. (e.g., waist circumference, smoking, physical activity level, and diet.)

All persons who are obese or overweight should try not to gain additional weight. In addition, those who are obese or who are overweight with other risk factors should consider losing weight. A complete health assessment by a physician is the best way to decide the right steps.

Whatever the BMI, talk to the patient to see if they are at an increased risk for disease and should lose weight. Even a small weight loss (just 5-10% of current weight over a 6 month period) may help to lower the risk of disease. One to two pounds per week of weight loss is a good goal.

Physical activity and good nutrition are key factors in leading a healthy lifestyle and reducing risk for disease. Visit our [Resource Section](#) for links to information on BMI, obesity, physical activity and nutrition. Webpage located at <http://www.cdc.gov/nccdphp/dnpa/bmi/resources.htm>.



## Common Myths

### Myth: BMI is a diagnostic tool

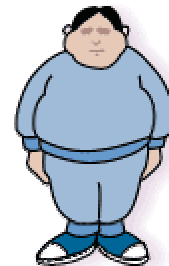
BMI alone is not diagnostic. It is one of many risk factors for disease and death. As a person's BMI increases, the risk for many diseases increases as well.

### Myth: BMI Measures Body Fat

Two people can have the same BMI, but a different percent body fat. A bodybuilder with a large muscle mass and a low percent body fat may have the same BMI as a person who has more body fat because BMI is calculated using weight and height only.



|         |               |         |
|---------|---------------|---------|
| 6'3"    | <b>Height</b> | 6'3"    |
| 220 lbs | <b>Weight</b> | 220 lbs |
| 27.5    | <b>BMI</b>    | 27.5    |



### Myth: BMI does not apply to all races and ethnicities

The World Health Organization adopted BMI in 1997 for use internationally across cultures and ethnicities. It also established the currently accepted BMI cut-off points for underweight, normal weight, overweight and obesity. BMI for adults is independent of age and reference population<sup>5</sup>



## BMI - Body Mass Index: BMI for Adults: Body Mass Index Formula for Adults

You can calculate BMI using either the English Formula in feet, inches, and pounds, or the Metric Formula in meters, centimeters, and kilograms.

### English Formula

Body Mass Index can be calculated using pounds and inches with this equation.

$$\text{BMI} = \left( \frac{\text{Weight in Pounds}}{(\text{Height in inches}) \times (\text{Height in inches})} \right) \times 703$$

For example, a person who weighs 220 pounds and is 6 feet 3 inches tall has a BMI of 27.5.

$$\left( \frac{220 \text{ lbs.}}{(75 \text{ inches}) \times (75 \text{ inches})} \right) \times 703 = 27.5$$

**This is easy to do on a calculator:  $220 \div 75 \div 75 \times 703 = 27.5$**

### Metric Formula

Body Mass Index can also be calculated using kilograms and meters (or centimeters).

$$\begin{array}{l} \text{BMI} = \frac{\text{Weight in Kilograms}}{(\text{Height in Meters}) \times (\text{Height in Meters})} \\ \text{or} \\ \text{BMI} = \left( \frac{\text{Weight in Kilograms}}{(\text{Height in centimeters}) \times (\text{Height in centimeters})} \right) \times 10,000 \end{array}$$

For example, a person who weighs 99.79 Kilograms and is 1.905 Meters (190.50 centimeters) tall has a BMI of 27.5.

$$\frac{99.79 \text{ Kg}}{(1.905 \text{ m}) \times (1.905 \text{ m})} = 27.5$$

**For adults BMI can also be found by using a table:**

[Body Mass Index for Adults Table \(PDF-15K\)](#)

This document is provided in Portable Document Format (pdf).

Web Page for BMI Table: <http://www.cdc.gov/nccdphp/dnpa/bmi/00binaries/bmi-adults.pdf>

**Content source:** [Division of Nutrition and Physical Activity, National Center for Chronic Disease Prevention and Health Promotion](#)

## **References**

<sup>1</sup> Garrow JS and Webster J. Quetelet's index ( $W/H^2$ ) as a measure of fatness. *International Journal of Obesity* 1985;9:147–153.

<sup>2</sup> Gallagher D, et al. How useful is BMI for comparison of body fatness across age, sex and ethnic groups? *American Journal of Epidemiology* 1996;143:228–239.

<sup>3</sup> World Health Organization. Physical status: The use and interpretation of anthropometry. Geneva, Switzerland: World Health Organization 1995. *WHO Technical Report Series*.

<sup>4</sup> Calle EE, et al. BMI and mortality in prospective cohort of U.S. adults. *New England Journal of Medicine* 1999;341:1097–1105.

<sup>5</sup> Kuczmarski J and Flegal KM. Criteria for definition of overweight in transition: background and recommendations for the United States. *Am J Clin Nutr* 2000;72:1074–81.

## **BMI - Body Mass Index: BMI for Children and Teens: How is it different?**

### **BMI for Children and Teens**

BMI for children and teens (2 – 20 years) is plotted on age and gender specific growth charts.

The BMI calculation is performed in the same way as for adults, but the resulting BMI figure must be plotted on a sex specific growth chart. The reason for this is that the amount of body fat changes with age (BMI for children and teens is often referred to as BMI-for-age.) Also, the amount of body fat differs between girls and boys.

**A percentile ranking for children and teens is obtained by plotting BMI for Age on a sex specific growth chart. Interpretation of BMI percentile for children and teens is based on four categories:**

| <b>Weight status category</b> | <b>Percentile range</b>  |
|-------------------------------|--|
| Underweight                   | Less than the 5 <sup>th</sup> percentile                         |
| Healthy weight                | 5 <sup>th</sup> percentile up to the 85 <sup>th</sup> percentile |
| At risk of overweight         | 85 <sup>th</sup> to less than the 95 <sup>th</sup> percentile    |
| Overweight                    | Equal to or greater than the 95 <sup>th</sup> percentile         |

A child whose BMI is at the 50th percentile is close to average because half of the kids in the sample group had a higher BMI and half had a lower BMI. A kid between the 85th and 95th percentiles is considered at risk of becoming overweight. And a child who measures above the 95th percentile is considered overweight because 95% of the population has a lower BMI than he or she does. A child below the 5th percentile may be considered underweight because 95% of the population has a higher BMI.



## How BMI Can Change for Children and Teens:

It's important to remember that BMI is interpreted differently for adults. The adult calculations don't use percentiles at all. There are just number ranges that are considered underweight, normal weight, overweight, or obese. That's because adults have stopped growing and their age is no longer a major consideration when it comes to weight. Kids, on the other hand, are growing. And it's common for kids to gain weight during certain times in childhood, such as puberty. The charts take growth into account. It is not appropriate to use the adult BMI tables to interpret the BMI of children and teens, as the adult tables do not take into account the bodily changes related to age and sex.

The following example shows how BMI can change, despite stability in percentile ranking.

Here's a look at a boy as he grows yet stays in the 50th percentile for BMI, which means he's average. Notice that his BMI goes up and down, but he continues to stay at the same percentile. Using a BMI range would not allow for these shifts in body weight and body fat.

| Age      | BMI Percentile |
|----------|----------------|
| 2 years  | 16.5 50th      |
| 4 years  | 15.8 50th      |
| 8 years  | 16.0 50th      |
| 12 years | 17.5 50th      |

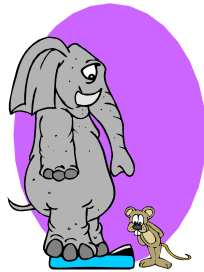
## Where BMI Can Fall Short

BMI is not the whole story when it comes to someone's weight. A more muscular child may have a higher weight and BMI, but not have too much body fat. Also, a smaller child could have an ideal BMI, but might have less muscle and too much body fat. Because of these and other considerations, BMI is only a screening tool, not a diagnostic tool. To determine whether the child has excess fat, further assessment would be needed. Further assessment might include skinfold thickness measurements. To determine a counseling strategy, assessments of diet, health, and physical activity are needed.

## Why can't healthy weight ranges be provided for children and teens?

Healthy weight ranges cannot be provided for children and teens for the following reasons:

- Healthy weight ranges change with each month of age for each sex.
- Healthy weight ranges change as height increases.



## What are the health consequences of overweight for children and teens?

Children and teens who are overweight may begin to experience health consequences during their youth as well as putting themselves at risk for weight-related health problems later in life. Overweight children and teens have been found to have risk factors for cardiovascular disease, including high cholesterol, elevated insulin levels, and elevated blood pressure during childhood. One study showed that approximately 60% of overweight children had a least one cardiovascular risk factor, such as high cholesterol or high blood pressure; in comparison, only 10% of children with healthy weight had at least one risk factor. Additionally, 25% of overweight children had two or more risk factors.<sup>2</sup>

Other health consequences include the following potential problems<sup>3</sup>:

- Type 2 diabetes
- Sleep apnea (not breathing for at least 10 seconds during sleep)
- Social consequences including poor self-esteem and social discrimination

In addition to the health problems they may experience during their youth, overweight children and teens are at increased risk for various chronic diseases as adults (including hypertension, type 2 diabetes, and coronary heart disease). Overweight adolescents are at greater risk of becoming overweight or obese as adults;<sup>4</sup> about one third of all severely obese adults were overweight children.<sup>5</sup>

Maintaining a healthy weight during childhood and adolescence may reduce the risk of becoming overweight or obese as an adult. Encourage children and teens to keep up healthy eating habits, participate in physical activity on most (preferably all) days of the week, and limit television viewing.

For more information, visit

[Tips for Promoting Healthy Eating and Physical Activity for Children and Teens.](http://www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/children_tips.htm)

Webpage: [http://www.cdc.gov/nccdphp/dnpa/bmi/childrens\\_BMI/children\\_tips.htm](http://www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/children_tips.htm).

**Content Source:** CDC Website at <http://www.cdc.gov>

## References

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<sup>1</sup>Mei Z, Grummer-Strawn LM, Pietrobelli A, Goulding A, Goran MI, Dietz WH. Validity of body mass index compared with other body-composition screening indexes for the assessment of body fatness in children and adolescents. *American Journal of Clinical Nutrition* 2002;75:97–985.

<sup>2</sup>Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa Heart Study. *Pediatrics* 1999;103:1175–1182.

<sup>3</sup>Must A and Anderson SE. Effects of obesity on morbidity in children and adolescents. *Nutrition in Clinical Care* 2003;6(1):4–12.

<sup>4</sup>Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine* 1997;37(13):869–873.

<sup>5</sup>Ferraro KF, Thorpe RJ Jr, Wilkinson JA. The life course of severe obesity: does childhood overweight matter? *Journal of Gerontology: Social Sciences* 2003;58B(2):S110–S119.

For more information link to [BMI for Children and Teens](#)

Web Page for BMI for Children and Teens:

[http://www.cdc.gov/nccdphp/dnpa/bmi/childrens\\_BMI/about\\_childrens\\_BMI.htm](http://www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/about_childrens_BMI.htm)

**OVERWEIGHT AND OBESITY:  
RESEARCH AND IMPLICATIONS FOR REPRODUCTIVE HEALTH**

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### **The public health impact of obesity.**

Obesity has become a major public health concern in the USA. Data from the CDC National Health and Nutrition Examination Survey (NHANES) show that 31% of all adults were classified as obese (body mass index<sup>1</sup> (BMI) of 30 or greater) in 1999-2002 compared with 23% in 1988-1994, and 15% in 1976-1980. Among children ages 6-19, 16% were overweight or obese (BMI >95<sup>th</sup> percentile) according to the 1999-2002 data compared with 7% in 1976-1980. Certain population groups are disproportionately at-risk for obesity including African-Americans, Latinos and low-income individuals (see more detailed analysis in the Appendix). Obesity is a chronic, metabolic disease caused by multiple factors including physiological and genetic influences. Behavioral and environmental factors that contribute to overweight and obesity include excessive food intake and decreased physical activity, as well as an individual's cultural and social eating habits and emotional response to food.

The impact of obesity on morbidity and mortality is substantial. Obesity increases one's risk of developing life-threatening health conditions such as stroke, gall bladder and liver disease, asthma and various cancers, cardiovascular disease (CVD) and diabetes. Obese women and men have a three to four fold increased risk for developing hypertension (Colditz & Wolf 1996) compared to lean people. Women (and men) who are overweight (BMI between 25 and 29) are also at an increased risk, especially at younger ages (<45 years). In the USA, a study suggested 74% of hypertension in women is attributable to obesity (Wittman et al 1989). In both children and adults, obesity is associated with a detrimental lipid profile (elevated triglycerides and reduced high-density lipoprotein cholesterol). In women and men, both obesity and adult weight gain<sup>2</sup> are significant risk factors for developing coronary heart disease (Colditz & Wolf 1996). Studies suggested 57 to 70% of coronary heart disease in women and men is attributable to obesity (Manson et al 1990, Rimm et al 1995). A study also reported that women who gained 40lb or more since young adulthood had a seven fold greater risk of dying from coronary heart disease and three times the risk of dying from CVD compared to women who maintained a stable weight (Manson et al 1995).

Studies have consistently shown increased risk (3 to 20 times) of developing Type 2 diabetes in both obese women and men. Early obesity and weight gain, regardless of current BMI, also increase the risk of developing Type 2 diabetes. Among obese women and men, 90% of their Type 2 diabetes is attributable to obesity<sup>3</sup> (Colditz et al 1995, Colditz & Wolf 1996). The prevalence of diabetes among adults has nearly doubled in the past decade and is increasingly being diagnosed in children and adolescents (PHMC 2002).

### **The practical implications of obesity to family planning providers.**

Weight related issues are not new to the family planning field. Weight gain is an often-cited concern of contraceptive users and can lead to method discontinuation or switching, putting women at-risk of an unplanned pregnancy. Nor are cardiovascular disease and diabetes alien topics to the family planning provider. As a preventive health service, the family planning program conducts a thorough health screening of each family planning client, educating women and men about family and individual health

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<sup>1</sup> See Appendix for obesity data and terminology.

<sup>2</sup> More than 26lb since age 21.

<sup>3</sup> Obesity is commonly associated with elevated plasma levels of free fatty acids. These produce insulin resistance in the skeletal muscle and the liver while potentiating glucose-stimulated insulin secretion from the beta cells of the pancreas. The failure of this compensatory mechanism leads to Type 2 diabetes in 20% of obese insulin-resistant people (Boden 2003).

risk factors. In addition to a reproductive clinical examination, this assessment includes height and weight measurements, a blood pressure reading and a general physical examination including the heart and lungs. Identified health problems are referred to primary or specialty care providers. For many men and women of reproductive age (15-45yr), the family planning program is their major source of health care and acts as a “gateway” into the health care system, particularly for those who are low-income and uninsured and might not otherwise interface with the health care system.

This review is intended to stimulate the family planning world - service providers, funders and policymakers - to consider the benefits and interconnections of identifying and addressing overweight and obesity in the context of providing routine reproductive health services. To be sure, this is uncharted territory. Client-centered educational and intervention models need to be designed and tested that do not stigmatize or alienate family planning clients. Further, faced with rising costs of contraceptive supplies, diagnostic tests and clinical care, publicly funded family planning programs are hard pressed to consider adding or integrating services, no matter how vital, without proper resources and training.

Yet, as this paper reveals, there are tangible rewards for the public health of this nation and an opportunity to further reduce health disparities related to diabetes and cardiovascular disease. The Title X Family Planning Program has three decades of data showing that that family planning services reduce health disparities among racial and ethnic populations related to contraceptive use (Gold 2002). Reducing health disparities is one of the two overall goals of Healthy People 2010 and one of the primary objectives of the Department of Health and Human Services (DHHS). The Title X Family Planning Program has established national program priorities that emphasize improvements in the overall health of individuals and communities by promoting family planning and preventive health services to low-income, hard-to-reach populations.

The national family planning system reaches large numbers of individuals and groups who are more at-risk for obesity and obesity-related health outcomes. Low-income individuals are at greater risk of obesity. Yet because of rising numbers of uninsured individuals, many low-income persons with obesity-related health conditions go undetected and untreated each year. One in five women of reproductive age were uninsured in 2003. This is a 10% increase since 2001 (Alan Guttmacher Institute, 2005) and emphasizes the crucial role for publicly-funded health services such as Title X services in reaching low-income, uninsured women. Eighty-four percent of the individuals served by the Title X program in 2003 had family incomes below 150% of poverty (2003 Family Planning Annual Report National data). For many women aged 15 to 55, family planning programs are their only continuing source of health information and clinical care (Alan Guttmacher Institute, 2003).

Obesity risks can be reduced by early intervention. The Title X Program serves a largely young demographic. Fifty-nine percent of family planning users in 2003 were under the age of 25 yr. Attempts to reach these groups before the full health impact of obesity is established can potentially prevent or ameliorate the serious consequences of diabetes and CVD. Those individuals most likely to experience health disparities (African Americans and Latinos) are over-represented in the Title X Program as compared to the general population. Twenty percent of all family planning users are African American females and 21% are Latina females; 25% of all male users are African American (2003 Family Planning Annual Report National data).

One family planning grantee in DHHS Region III is assessing the prevalence of obesity among family planning consumers and will follow that with a series of focus groups with both consumers and providers to determine practical and feasible interventions for reproductive health providers.

Preliminary data from 291 women at two family planning clinics in Philadelphia County (largely African American and Latino women) reveal that 70% have a BMI above 25 (i.e. overweight or obese) and 49% of women are at-risk on waist circumference measurements. In one clinic that assessed glycosylated hemoglobin levels (HbA1c), 17% have borderline to abnormal HbA1c levels, suggestive of undiagnosed diabetes risk. In both clinics, 61% of the women report a family history of diabetes.

At a minimum, this report raises the question: What is the role of the Title X Family Planning Program in identifying and educating consumers who are obese and at-risk for diabetes and/or CVD and referring them for further evaluation and care? Furthermore, this report aims to build an understanding of the important ways that overweight and obesity intersect with reproductive health through a thorough examination of the research literature. It examines what is known and what is not yet known about the effects of obesity on reproductive health, covering the major events of the life span, from puberty to menopause, in both women and men. While a variety of important questions concerning effects, mechanisms and interventions remain open for debate, many studies show that being overweight or obese has significant consequences for reproductive health. This poses challenges to, and has implications for, the family planning system. There follows (in the Summary and Conclusions section) a review of intervention studies and implications for research and practice. The reader may consult the terminology section in the Appendix to find data on obesity prevalence, the current definitions of obesity as well as comments on the challenges of drawing consensus from research studies that use different terms, not always applied consistently. There is also a brief summary of sex steroid physiology to explain the link between estrogens, androgens and obesity.

### **Body weight and sexual maturation**

#### Body weight and its impact on sexual maturation in girls

##### *Overview*

- There is a clear association between increased prevalence of overweight/obesity and earlier sexual maturation.
- An earlier hypothesis that a critical amount of fat triggers puberty is not confirmed by recent research.
- Causal evidence that obesity influences sexual maturation is inconclusive.
  - One study: increased body fat at ages 5 and 7yr. predicts earlier puberty at 9yr.
  - Other studies: increases in body fat during puberty are a result, not a cause, of early puberty.
- Regardless of causality, early maturing females are more likely to be obese during adolescence and into adulthood
- Variation in puberty onset between races is only partly explained by BMI differences.
- Research is needed to discern effects of genetics, socio-environment, etc. that may influence puberty onset.

##### *Research studies*

The recent trends in the earlier onset of puberty among girls coincide with increases in the prevalence of childhood obesity. A study (Wattigney et al 1999) found that black and white girls from a 1992–1994 cohort were more overweight and were twice as likely to reach menarche before 12 years than similar-aged girls from an earlier cohort, 1978–1979. Others have reported a much smaller decrease over the past 20 years in menarcheal age in white girls than in black girls (Freedman et al 2002). Research has revealed positive associations between degree of overweight and timing of puberty, such

that girls who are overweight experience earlier puberty than girls who are not overweight (Morrison et al 1994, Kaplowitz et al 2001).

The causal direction of this association is unresolved and additional prospective research is needed. Increased body fat could be driving earlier initiation of puberty among girls, according to the Frisch hypothesis (Frisch 1984) that asserted that a critical amount of body fat is necessary to trigger the onset of puberty among girls. Other recent studies (e.g. Trussell 1980, de Ridder et al 1992) have found this not to be true.

It has been suggested from cross sectional (e.g. Wang 2002) and longitudinal studies (e.g. de Ridder et al 1992, Demerath et al 2004) during puberty that increases in BMI are a consequence, rather than a determinant, of early sexual maturation. However, a recent longitudinal study (Davison et al 2004) indicated that higher percent body fat and greater abdominal fat at 5 and 7 years and greater increases in these variables across middle childhood are causally implicated in earlier timing of puberty at 9 years among white girls. These studies agree that the important consideration is that early maturing females are more likely to be obese during adolescence and into adulthood. Others have suggested that menarcheal age has little effect on adult obesity independent of childhood obesity (Freedman et al 2003).

Additional research is needed to determine if higher levels of body fat precede pubertal onset in girls from different racial and ethnic groups and whether differences in fat levels during early childhood can help to explain earlier onset of puberty in Hispanic and African American girls (mean age at menarche 12.3 yr) in comparison to white girls (mean 12.6 yr) (Morrison 1994, Kaplowitz et al 2001, Adair and Gordon-Larsen 2001)). The greater differentiation of breast and pubic hair development (on average 1 year earlier in black girls than white girls) is only partly accounted for by differences in BMI (Kaplowitz et al 2001). Another study by Freedman et al (2002) showed that after adjusting for BMI, menarche was still earlier in black girls than white girls. After adjusting for sexual maturation, racial differences in BMI at age 10 were insignificant (Morrison et al 1994) but body fat for black girls became significantly greater at 12 years (and thereafter) compared with white girls (Kimm et al 2001, Morrison et al 2001).

One likely mechanism for the link between early obesity and early onset of puberty in girls is that excess estrogen<sup>4</sup> produced by increased body fat may be a trigger for earlier onset of puberty. Research suggests that the central accumulation of body fat has a strong influence on levels of estradiol among pubertal-aged girls (de Ridder et al 1990). Another likely mechanism is that obesity is associated with higher concentrations of leptin. Recently discovered, leptin is released from the adipocytes and may act as a metabolic signal to the hypothalamic pituitary gonadal axis for increased production of sex steroids<sup>5</sup>. Estradiol itself may stimulate leptin during female puberty (Demerath et al 1999) and promote the development of adipose tissue. In prepubertal girls, leptin concentrations increase slowly with age and body-fat mass. In girls, leptin and body-fat mass continue to increase during puberty (Apter 2003). Leptin's role is still rather undefined but evidence indicates that leptin is not a primary signal that initiates puberty but rather that it acts in a permissive way as one of several metabolic factors that facilitate pubertal maturation. For instance, it has been suggested (Kaplowitz et al 2001, Mirza et al 2004) that hyperinsulinism (associated with obesity) may play a role by direct and indirect stimulation of ovarian and adrenal steroids. Studies also show that numerous factors including socioeconomic conditions, genetic predisposition and accelerated growth influence sexual maturation

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<sup>4</sup> See Appendix section on sex steroids.

<sup>5</sup> Leptin also influences appetite and basal metabolic rate.

and in fact may be the common causes of both early onset of sexual maturation and obesity (Wang 2002 and others).

### Body weight and its impact on sexual maturation in boys

#### *Overview*

- The association between overweight/obesity and earlier sexual maturation in boys is inconclusive.
- A national study showed that earlier maturing boys were less likely to be obese.
- A Hispanic community study found that obesity was positively associated with increased sexual maturity.

#### *Research studies*

A cross-sectional nationally representative sample of boys and girls (Wang 2002) showed that early sexual maturation was negatively associated with obesity in boys aged 8 to 14. The authors attribute this to early-maturing boys showing increased development of lean body mass. In prepubertal boys (as in girls), leptin concentrations increase slowly with age and body-fat mass. In boys this increase is interrupted in early puberty, when leptin falls while testosterone and lean body mass increase. Most differences between ethnic groups in overweight and obesity in boys (and girls) disappeared after controlling for sexual maturation. Another study (Mizra et al 2004), amongst predominantly El Salvadorian children in Washington DC, found that in boys aged 6 to 11, obesity was positively associated with increased sexual maturity. Clearly studies among boys that aim to be nationally representative may draw different conclusions compared with studies in more homogeneous ethnic and racial communities, which may be mediated by unmeasured genetic and socio-environmental factors.

### **Body weight and contraceptive effectiveness**

#### *Overview.*

- The effects of body weight on the efficacy of combination oral contraceptives (OC) are small and inconclusive. Most experts believe benefits of pregnancy prevention would outweigh any small changes in OC effectiveness.
- The transdermal contraceptive patch may be less effective in women who weigh 198 pounds or greater, but a cause-and-effect relationship has not yet been elucidated.
- The influence of body weight on the effectiveness of combined hormonal injections (Lunelle), progestin-only pills, progestin injections (Depo-Provera) and 5 yr progestin implants (Norplant) seems insignificant.
- Not enough research has assessed the combined hormonal vaginal ring (NuvaRing), the progestin-only intrauterine system (Mirena) or the 3yr progestin implants (Implanon) for efficacy in obese women.
- Research on excessive weight and contraceptive effectiveness:
  - Lacks inclusion of overweight and obese women.
  - Contraceptive failure rates are so low that large sample sizes are needed.
  - Needs to control for effects of reduced fertility for women with excessive weight.
- Table 1 (at the conclusion of this section) summarizes study findings on body weight and effectiveness for each method category described below.

#### *Research studies*

Obesity contributes to hypertension, diabetes and other cardiovascular risk factors that may preclude the use of some combined hormonal contraceptives, especially in older women. This may partly

account for clinical trials of contraceptives in general having excluded overweight or obese women and so the association between obesity and contraceptive failure may be largely unknown. The rarity of contraceptive failure in clinical trials also means that without a very large number of subjects research has inadequate power to detect effects. The association of body weight with contraceptive efficacy merits further study in overweight or obese women and will need to account for variation in compliance and fertility. Some studies examining the relationship between body weight and contraceptive failure have involved hormonal contraceptive methods that are not widely used or are no longer available but are included here so as to be comprehensive. Little is known for any method about the influence of significant weight gain or weight loss (during contraceptive use) on contraceptive effectiveness.

Combined (estrogen plus progestin) OC.

Holt et al (2005) report a case-control study of 248 women who became pregnant while using OC and found the risk of pregnancy was 60% higher in women with BMI greater than 27.3. Overweight consistent OC users were more than twice as likely as other consistent users to become pregnant. The potential physiological explanations they give for their findings of failures in heavier-weight users include an enhanced metabolic rate<sup>6</sup>, leading to more rapid metabolism of sex steroids and subsequently insufficient hormone levels needed to sustain good contraceptive efficacy (Holt et al 2002). There may also be differences in pharmacokinetics due to absorption of steroids in altered fat tissues. This would suggest a linear relationship extending over the whole range of BMI, but they found no graded decrease in OC failure in those women with BMI below 27 while risk of failure for BMI above 27 was fairly constant.

Holt et al (2002) published a retrospective analysis of 106 pregnancies in 618 OC users and suggested that body weight might influence the effectiveness of OC. They found that women in the highest bodyweight quartile (155+ lb)<sup>7</sup> were 60% more likely than women in the lower body-weight quartiles to have experienced contraceptive failure resulting in pregnancy. The perfect-use annual failure rate for all OC users is 0.3% (Trussell 2004) and a 60% increase in the relative risk for failure translates into a small absolute risk of 0.5% for women who weighed 155 pounds or greater. If the increased risk for women who weighed 155 pounds or greater is calculated against typical-use OC failure rates (8%, Trussell 2004), a 60% increase in relative risk makes the typical-use OC failure rate more substantial (13%), similar to that of the male condom (15% typical-use failure).

Preliminary data from a retrospective study (Norris et al 2003) in combination OC users found a positive correlation between contraceptive failure and increased BMI. Of 514 combination OC users, 7 became pregnant; of those 7 women, 5 had a BMI greater than 25, and 3 of these 5 women had a BMI greater than 30. In contrast, Kaunitz (2002) investigated the relationship between body weight and contraceptive effectiveness in women using a low-dose OC. Twenty pregnancies in 1723 users, when analyzed by weight group quartile, as defined in the study by Holt et al (2002), showed no statistical difference between the highest and lowest groups.

Similarly, Vessey (2001) reported no relationship between body weight and effectiveness of combination OC in a study that compared failure rates between women weighing less than 180 pounds and those who weighed 180 pounds or more. Although the failure rate was higher for the heavier

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<sup>6</sup> As the total body mass increases, resting metabolic rate increases and an obese person has a higher rate than a lean person of the same height (Nussey & Whitehead 2001).

<sup>7</sup> 155lb in weight corresponds to a BMI of 25 in a woman of average height (5ft 6 in) and only corresponds to obesity in women of 5ft or less.

group, it was based on only three pregnancies, and the difference between groups was not statistically significant. In sum, three studies suggest an effect but two studies do not, therefore further study is needed to assess the significance of these findings.

#### Transdermal contraceptive system.

The contraceptive efficacy of the combination hormonal contraceptive patch (Ortho Evra®, Ortho-McNeil, Raritan, NJ) was studied in more than 3300 women for more than 22,000 treatment cycles. It is important to note that the contraceptive patch studies did enroll women with a wider range of body weights ( $\pm 35\%$  of ideal body weight) than did many OC studies. When analyzing pooled results from three multicenter studies, researchers found that the patch may have been less effective in a subgroup of women weighing 198 pounds<sup>8</sup> (90 kg) or more (Zieman et al 2002). Only 3% of study subjects were in this weight range. Five pregnancies occurred in this subgroup of women (four of them in a single study, Smallwood et al 2001). In these trials, pregnancies were rare, and for the ten pregnancies in the 97% of women who weighed less than 198 pounds there was no association between body weight and pregnancy.

As a result of these multicenter studies, the efficacy of the contraceptive patch is no longer considered to be in the "highly effective range" for body weights greater than 198 pounds (Creinin 2004). That is, for heavier women, patch effectiveness is equivalent to barrier methods. This implies that the failure rate for the patch (0.3% for perfect users overall) has become 2% (equivalent to the condom in perfect use (Trussell 2004)) in women over 198 lb, but Zieman et al (2002) did not published data to substantiate this assertion. More data are needed to understand this weight effect; for instance, does patch placement location matter and are factors such as altered pharmacokinetics and endogenous estrogen production involved? Zieman et al (2002) reported that only 10-20% of variability in hormonal pharmacokinetic data could be explained by body weight. They present no data to show whether increasing the dose in overweight women would make the patch more effective. A cause-and-effect relationship would also need to account for the fact (detailed in the next section) that overweight and obese women have reduced fertility. If true, the association between obesity and contraceptive failure could hold for other hormonal contraceptive methods as well since heavier-weight women have routinely been excluded from participation in trials evaluating methods other than the patch.

#### Other combined hormone contraceptives.

To date, the etonogestrel/ EE vaginal ring (NuvaRing®; Organon, West Orange, NJ) has been studied primarily in Europe; no data regarding heavier-weight women and contraceptive failure are available from these studies. In two open-label, non-comparative efficacy trials with the etonogestrel/EE ring, fewer than 1% of participants had a BMI greater than 29.9 (and the majority of pregnancies were because of non-compliance), so it was impossible to form any conclusion about the relationship between body weight and contraceptive failure (Roumen et al 2001, Dieben et al 2002). Rahimy et al (1999) studied the impact of body weight on the effectiveness of the combined monthly injectable (Lunelle) in normal and overweight/obese women and suggested that minor differences observed in the progestin pharmacokinetics due to body weight have no impact on the contraceptive efficacy since progestin concentrations are well above the threshold levels required to suppress ovulation.

#### Progestin-only pills (POP).

A randomized, double-blind trial in the UK of four POP (Vessey et al 1972) revealed that women who experienced unplanned pregnancies, as compared with women who did not become pregnant, were on

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<sup>8</sup> 198 lb denotes obesity (BMI 30) in women 5 ft 8 inches tall or less.

average slightly older and slightly heavier. However, neither effect was statistically significant. A UK study series reported that the highest failure rate occurred in women with the highest body weight, but that the numbers were too low to draw any meaningful conclusions (Vessey et al 1985, Vessey et al 1990, Vessey 2001).

#### Progestin injection (Depo Provera).

There are no data to suggest that the contraceptive efficacy of the Progestin injection Depo-Provera is affected by patients' BMI. There were no significant differences in Depo-Provera pharmacokinetics between normal weight, overweight and obese women (Jain yet al 2004).

#### Vaginal ring – progestin only.

In 1990, the World Health Organization (WHO) studied the relationship between body weight and failure of a levonorgestrel (LNG)-containing vaginal ring (Koetsawang et al 1990). Results from Thailand showed that heavier women had consistently higher rates of pregnancy than did women with lower body weights. Pregnancy rates ranged from 2% in women weighing 88 pounds (40kg) to 10% in those weighing 176 pounds (80kg). It is not clear if this study (and the implant study below) controlled for possible reduced fertility in low weight women. Moreover, the WHO study included data on a progestin-only ring, not on the currently marketed combined hormone product containing etonogestrel and EE (NuvaRing).

#### Progestin implants.

Clinical trials with progestin implants (Norplant® System; Wyeth Pharmaceuticals, Collegeville, PA) suggested a positive correlation between body weight and pregnancy rates (Dias and O'Mara 1998) The 5-year cumulative pregnancy rate for women using progestin implants was 0.2% in those who weighed less than 110 pounds versus 8.5% in those weighing more than 154 pounds (Norplant package insert 1997). Large-scale studies in China over 7 years reported similar findings but they translate into an annual pregnancy rate of less than 1 percent for those women over 155 lb (Gu et al 1995). Creinin (2004) suggests differences in the thickness of the tubing of original implants may have accounted for the Chinese findings and that no differences in efficacy have been demonstrated in the thin tubing product marketed in the USA (Sivin et al 2000). A European study (Huber and Wenzl 1998) did report that lower body weight was associated with higher serum etonogestrel concentrations in Implanon® (Organon Labs) users but gave no data on effectiveness. A review of a small number of reported failures with Implanon found no association between body weight and efficacy (Mansour 2004).

#### Barrier contraceptives and intrauterine devices.

The male and female barrier methods have no adequate studies to indicate whether a man's or a woman's weight will affect contraceptive performance. However, weight change of more than 7lb considered an indication for women to be remeasured for the diaphragm though the physiological reason is unclear. Holt et al (2002) reported no association between barrier method failure and high body weight. Creinin (2004) states that the contraceptive efficacy of intrauterine contraceptives does not vary based on a patient's weight. A systematic review of the progestin-only intrauterine system (Mirena) made no mention of body weight as a factor (French et al 2004).

#### Other contraceptive methods

Female sterilization under general anesthesia poses increased anesthetic risk for obese and overweight women. The ability to perform successful laparoscopic sterilization can be affected by patients' weight but the post-procedure efficacy has not been shown to be weight dependent. Recent reviews of male sterilization and potential new male methods (both hormonal and non-hormonal, Anon 2005, Grimes et al 2005) make no mention of taking obesity into account when examining contraceptive effectiveness.

Table 1. Body weight and contraception effectiveness summary

| Contraceptive method                        | Overweight reduces effectiveness |
|---|----------------------------------|
| Combined patch (Ortho Evra)                 | reduced if >198lb                |
| Progestin-only vaginal ring                 | yes, incremental                 |
| Combined OC                                 | small, inconclusive              |
| Combined monthly injectable (Lunelle)       | not significant                  |
| Progestin-only pills                        | not significant                  |
| Progestin injection (Depo Provera)          | not significant                  |
| Progestin 5yr implant (Norplant)            | not significant                  |
| Progestin 3yr implant (Implanon)            | no evidence                      |
| Combined vaginal ring (NuvaRing)            | not studied                      |
| Progestin-only intrauterine system (Mirena) | not studied                      |

### Contraceptives: effects on body weight

#### Overview

- Weight gain with combined hormonal contraceptive use (OC, Patch, vaginal ring, monthly injectable) is a common perception but is not a proven fact.
- Weight gain with progestin contraceptive use remains a significant concern only with Depo-Provera. Studies show wide variation.
- Research is needed to assess weight gain in obese women on Depo-Provera, as well as weight loss after stopping Depo-Provera.
- Table 2 (at the conclusion of this section) summarizes study findings on weight gain for each method category described below.

#### Research studies

Concerns about weight and weight gain often affect how women select and use birth control methods. Because women can gain weight over time unrelated to contraceptive use, studies with control groups are necessary to make informed comparisons. A recent review (Zukoski et al 2004) of the relevant research literature notes that “Few studies look at weight gain as a primary outcome. The majority of studies use weaker study designs that are quasi-experimental or non-experimental designs. Randomized control trials represent the most rigorous approach for determining a causal association. Additionally, studies of women’s concerns about contraceptive use and weight gain used small samples thus the results are hard to generalize to broader populations. Finally, there is little literature to review related to best practice or evidence based practice that address weight concerns and contraceptive use.”

#### Combined hormonal contraception.

Many women and clinicians perceive weight gain as a side effect of combined hormonal contraception (Anon 2003). In adult women, weight gain represents the most commonly cited reason for discontinuing oral contraceptives (OC); one in five women cited weight gain as a reason for discontinuing OC or avoiding the method altogether (Rosenberg et al 1995; Rosenberg 1998; Wysocki 2000). Teenage OC users who discontinued the pill were more likely to report perceived weight gain than those who continued, even though actual weight was often unchanged. Body composition studies have shown no weight gain or increased body fat in young women using OC for an average of 28 months, compared to non-users (Lloyd et al 2002). A recent systematic review (Gallo et al 2004) examined the effects of combined hormonal contraception (including OC, the contraceptive patch,

vaginal ring and monthly injectables (Lunelle)) on body weight and found no evidence supporting a causal relationship. Though no large effect on weight (more than 1 kg/2lb) was apparent, because many studies did not include a placebo or non-hormonal control group, the reviewers concluded that sufficient evidence does not exist to determine the effect of combined contraceptives on weight and more research is needed. Overweight and obese women do not seem to have been adequately studied.

### Progestins - Depo-Provera

With Depo-Provera, weight gain is a well-documented side effect that tends to continue with ongoing use and is a common reason for discontinuation of this effective method (Anon 2003). The Depo-Provera package insert lists predictable average weight gain (cumulative) for women of average body weight (136lb): 5lb in the first year, 8lb after two years and 14lb after 4 years. Published studies show wide variation. A UK study of Depo-Provera use reported mean weight gain after one year of 4lb, rising to a mean of 20lb with 5.5 years of use (Bigrigg et al 1999); the comparison group was not stated. A retrospective study from Brazil (Bahamondes et al 2001) that looked at long-term use found that adult Depo-Provera users gained on average 9lb (7% of body weight) over 5 years, compared to 4lb (3% of body weight) in IUD users. A study in Navajo women (Espey et al 2000) found mean weight gain (relative to the comparison group) was 11lb after two years of Depo-Provera use. A study in Thai women (Taneepanichskul et al 1999) found that adult Depo-Provera users gained on average 21lb (18% of body weight) over 10 years, compared to 26lb (23% of body weight) in IUD users.

Studying adolescents, Risser et al (1999) found a mean weight gain of 7 lb by one year of Depo-Provera use. Fifty-six percent of Depo-Provera users lost weight or gained < 5% of their baseline weight; 25% of Depo-Provera users gained > 10% of their baseline weight. Age, baseline BMI, or race/ethnicity did not predict weight gain. In contrast, Mangan et al (2002) found that (after adjusting for age and race) initial BMI was associated with weight gain over one year of Depo-Provera use, suggesting that girls who are overweight when starting Depo-Provera are at increased risk for weight gain. While 45% percent of all Depo-Provera users lost weight or gained < 5% of their baseline weight, 66% of initially overweight girls gained more than 10lb. Bonny et al (2004) found, at 6 months of Depo-Provera use, increases in weight and body fat that, though greater in black than in white girls, were positively related to baseline weight in both groups. They also found that appetite decreased when on Depo-Provera. However a comprehensive 14 –month study suggested that when weight gain occurs in Depo-Provera users, it is mainly associated with increased fat deposition due to increased appetite and food intake rather than fluid retention (Amatayakul et al 1980).

Questions remain as to how much incremental weight gain is seen in overweight and obese women (who seem not to have been adequately studied) and whether the weight gain implies any health risk. Further questions involve how much and how quickly this weight gain will be lost once the method is discontinued; studies have noted increased BMI persisting for 6 months (Harel et al 1996) in non-obese adolescents.

### Other Progestins

No studies have reported a significant association with weight change in POP users. A randomized comparison of the progestin-only intrauterine system with the copper IUD failed to show an increase in weight (Andersson et al 1994). Two studies have documented weight gain (on average 2 to 4 lb in one year) associated within Norplant use (Berenson et al 1997, Sivin et al 1998) while two other studies reported no increase in weight or BMI in adult Norplant implants users over a one (Moore et al 1995) or five-year study period (Pasquale et al 1994). Weight increase of at least 2 lb has been reported in Implanon users over 2 years (Edwards and Moore 1999), though it is not clear how much is attributable to implant use rather than gains that might have occurred anyway.

Table 2. Contraception and effect on body weight summary

| Contraceptive method                        | Method effects on body weight |
|---|-------------------------------|
| Progestin injection (Depo Provera)          | add 5lb/yr                    |
| Progestin 3yr implant (Implanon)            | inconclusive                  |
| Progestin 5yr implant (Norplant)            | inconclusive                  |
| Combined OC                                 | not significant               |
| Combined patch (Ortho Evra)                 | not significant               |
| Combined vaginal ring (NuvaRing)            | not significant               |
| Combined monthly injectable (Lunelle)       | not significant               |
| Progestin-only intrauterine system (Mirena) | not significant               |
| Progestin-only pills                        | not studied                   |
| Progestin-only vaginal ring                 | not studied                   |

### Body weight and infertility

#### Overview

- Obese women have increased ovulatory infertility and reduced success during fertility treatment.
- Obesity is associated with menstrual disturbances, improved by weight loss.
- About 50% of polycystic ovary syndrome subjects are obese or overweight. Weight loss improves fertility.
- Data suggest normal fertility in obese men but reduce androgens and erectile dysfunction are common in those obese and over 40yr.

#### Body weight and female fertility

There is a high prevalence of obese women in the infertile population. While many studies have highlighted the link between obesity and infertility, these studies were often based on select groups of women, focused mainly on ovulatory dysfunctions (rather than obesity per se), which may have biased results. However there is clear evidence that obesity is associated with several reproductive disorders including reduced fertility, polycystic ovary syndrome (PCOS) and menstrual disturbances. The mechanisms are complex and still not completely understood. The association between overweight/obesity, insulin resistance and abnormal secretion of insulin, testosterone and other hormones underlies many reproductive disorders observed in this population (Norman et al 2004).

Two European studies have shown a strong association between overweight/obesity in women and delayed conception (that exceeded 9 months of unprotected intercourse) (Lake et al 1997, Bolumar et al 2000). Fat distribution may play a role since fertile women with central adiposity (increased fat in the abdomen) take longer to become pregnant than women of the same BMI with peripheral adiposity (increased fat tissues other than the abdomen) (Zaadstra et al 1993). The mechanism of this effect is unclear but may be related to increased central fat being associated with higher levels of circulating insulin and increased insulin resistance. While many obese women achieve pregnancy readily, studies report that the risk of ovulatory infertility is 70% higher in women with BMI 26-28 and 170% higher in women with BMI >29 (Rich-Edwards et al 1994). (This study also found a 20% increased risk of infertility associated with BMI <16). Another study found ovulatory infertility was 3 times more common in women with a BMI >27 (Grodstein et al 1994). Several reports show that obese and overweight women have reduced success during infertility treatment and embryo transfer (see Norman et al (2004) for review).

Body weight and Polycystic ovary syndrome (PCOS)

A large proportion of infertile women have PCOS, characterized by ovarian changes, menstrual disturbances, raised androgens and other metabolic anomalies. Over a third to 50% of PCOS subjects are overweight or obese (Balen et al 1995). In women with PCOS, obesity worsens both their symptoms and their endocrine profile and even normal weight PCOS subjects have increased intra-abdominal fat (Norman et al 2004) and increased insulin resistance. Consensus on the etiology of PCOS and role of obesity and insulin has been hampered by the lack of a uniform definition of PCOS and the heterogeneous nature of the syndrome but studies (Wright et al 2004) favor metabolic rather than dietary and lifestyle antecedents<sup>9</sup>. By these mechanisms, obesity may also favor resistance to clomiphene and gonadotrophin-induced ovulation and reduce outcomes of IVF/ICSI procedures (Pasquali et al 2003). Weight loss in hyper-androgenic obese anovulatory women will normalize insulin sensitivity, and androgen and SHBG levels. It has been demonstrated that weight loss of 10% can improve the fertility of obese women through the recovery of spontaneous ovulation, whereas others will have improved response to ovarian stimulation in infertility treatment (Norman et al 2004).

Body weight and menstrual irregularities

Hartz et al (1979) showed that 45% of women with amenorrhea were obese whereas only 11% of women with normal cycles were overweight. Lake et al (1997) found that women who were underweight, overweight or obese were increasingly likely to have menstrual disturbances. Obesity in childhood and early adulthood increases the risk of menstrual irregularities. Long cycles (which tend to be anovulatory) are associated with increasing body mass (Rowland et al 2002). For subjects with PCOS, obesity makes menstrual irregularities more likely (Balen et al 1995) and weight loss improves menstrual function. In obese women with menstrual irregularities (without PCOS), weight loss of 20lb (~10%) causes significant improvements in menstrual function and conception (Hollmann et al 1996).

Body weight, men and fertility

There are few data on reproductive outcomes in the overweight male. In the majority, reproductive function is satisfactory, with a normal semen analysis, potency, tumescence and libido (Norman and Clark 1998). However, a recent Danish study of (young) military recruits showed reduced sperm concentrations and reduced serum testosterone associated with high (>25) BMI (Jensen et al 2004). Though they found that levels of bioavailable (free) testosterone were sustained in obese men, others have shown that in older men reduced free testosterone is related to increased BMI (Zumoff et al 1990, Haffner et al 1993) and the Massachusetts Male Aging Study of men aged 40 to 69 also reported reduced androgen levels in obese men (Gray et al 1991). In women, there is a positive association between body fat and androgens which may be reversed in overweight/obese men, perhaps mediated by gender differences in the association between androgens and leptin (Soderberg et al 2001).

**Body weight and pregnancy***Overview*

- Maternal obesity negatively affects maternal and infant outcome.
- Maternal obesity increases lactation failure and post-partum anemia.

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<sup>9</sup> In overweight women and/or those with PCOS, abdominal fat causes an increase in the number of fat cells that results in a cascade of changes, involving increased insulin resistance and increased levels of leptin, insulin and luteinizing hormone. These changes stimulate the partial development of ovarian follicles that secrete supranormal levels of testosterone, but which rarely ovulate (hence low progesterone). Raised insulin levels reduce sex hormone-binding globulin (SHBG) that amplifies ovarian testosterone production/action (Norman et al 2004). The role of pituitary leptin resistance and whether elevated leptin levels have a direct inhibitory effect on the ovary in determining anovulation in obese women is unclear.

- Obesity does not predict excess weight gain during pregnancy, but excess weight gain during pregnancy predicts post-partum weight retention and long-term weight gain.
- Research is needed on successful antenatal and postnatal weight management programs for obese women, especially among racial/ethnic subgroups most at risk.

#### The impact of obesity during the antenatal and perinatal periods.

A recent report (of patients at publicly funded hospitals in Alabama) quotes a 20% increase over the past 20 years in mean maternal weight at first antenatal visit and the percentage of obese women at first antenatal visit increased from 7 % to 24% (Lu et al 2001). Women who are obese at the onset of pregnancy experience more pregnancy complications than do normal weight or overweight mothers. The basis of many complications is likely to relate to the altered metabolism associated with obesity. (Some studies see increased risks also in overweight women). Chronic hypertension and diabetes mellitus may already pre-exist and have pregnancy implications. Studies (Wolf 1998, Sebire et al 2001) have documented that the maternal risks due to obesity include a higher incidence of pregnancy-induced hypertension, gestational diabetes, thromboembolic disease and infections (including genital and urinary tract and wound infections). Perinatal risks include labor abnormalities, more inductions of labor, cesarean sections (both scheduled and unscheduled) and postpartum hemorrhage. Infants of mothers with obesity are at increased risk for late fetal death, early neonatal death and macrosomia (birthweights over 9lb) (Cnattingius et al 1998). Among obese women, the effect of pregnancy weight gain on birthweight is weak but obese women clearly have infants that are larger than those of non-obese women for the same weight gain (Institute of Medicine 1990). One study (Sebire et al 2001) notes a *reduced* risk for premature (<32 weeks) delivery in obese women while another study reports *increased* risk of premature delivery in nulliparous obese women (Cnattingius et al 1998). Data (Waller et al 1994, Pasquali et al 2003) suggest a greater risk for congenital malformations (including neural tube defects, spina bifida and other defects of the central nervous, circulatory and intestinal systems) in fetuses of obese mothers. Being overweight or obese is negatively associated with the prolactin response to suckling in the first week postpartum and may contribute to early lactation failure more common in overweight and obese women (Rasmussen and Kjolhede 2004). Obesity substantially increases the risk of postpartum anemia (Bodnar et al 2004).

Being overweight or obese is associated with increased risk of miscarriage during naturally conceived pregnancies (Hamilton-Fairley et al 1992). This study and others (e.g. Wang et al 2002) have established a positive relationship between BMI and the risk of spontaneous abortion in women who become pregnant after ovulation induction or assisted reproduction treatment.

#### Pregnancy weight gain, post-partum weight loss and its effect on obesity risks

Weight gain during pregnancy is poorly correlated with pre-pregnancy BMI (Institute of Medicine 1990). The weight gain associated with lowest rates of infant mortality and optimal birthweights is lower in obese (at least 6kg/13 lb) and overweight (7 to 12kg/ 15 to 26lb) mothers than those of normal weight (12 to 16kg/26 to 35lb) (Naeye 1979, Institute of Medicine 1990). A significant number of normal-weight women and an even greater proportion of overweight women exceed these guidelines. Extra energy intake is required by healthy pregnant women to support adequate gestational weight gain and increases in basal metabolic rate but Butte et al 2004 showed that while protein accretion during pregnancy did not differ between normal and overweight/obese women, fat deposition was almost twice as great in overweight/obese women. However, protein/energy restriction of pregnant women who are overweight or exhibit high weight gain is unlikely to be beneficial and may be harmful to the developing fetus (Kramer 2000). Postpartum weight retention was strongly related to weight gain during pregnancy in both normal and overweight women (Polley et al 2002). Their intervention to

reduce excessive weight gain during pregnancy succeeded with normal weight women but not with overweight women. Excess weight gain and failure to lose weight after pregnancy are predictors of subsequent long-term weight gain (Rooney and Shaubarger 2002) that can be reduced by breastfeeding and postpartum exercise. Another study on a national cohort of women followed for 10 years reported that becoming overweight was associated with childbearing but found little difference in excess weight gain between those having one live birth during the study and those having three (Williamson et al 1994).

### **Body weight and menopause**

#### *Overview*

- There is some evidence for earlier menopausal onset and increased symptoms in overweight/obese women; other studies find the reverse. The physiological explanations are unclear.
- The balance of evidence favors no menopause related effect on weight gain but studies on menopausal weight gain in obese women are lacking.

#### Obesity and its impact on menopause

The prevailing wisdom is that obese women have higher levels of estradiol and estrone than thin women because of greater peripheral conversion of androgens to estrogens in fat tissue (Erluk et 1982). This would suggest that heavier women have a lower risk for hot flashes (as seen in some older studies, Erluk et al 1982) but the results of Whiteman et al (2003) and other recent studies show that increasing BMI is positively associated with risk for hot flashes. There is some evidence to suggest that obesity can lead to earlier ovarian insufficiency in peri-menopausal women, as Klinga et al (1983) found that obese women experienced increased levels of follicle-stimulating hormone and decreased levels of estradiol and estrone an average of 4 years earlier than non-obese women. The underlying biological changes that lead to hot flashes are unknown and prospective studies are still needed to establish the temporal sequence of the menopause and hot flashes in obese women.

#### Menopause and its impact on obesity

The years surrounding the menopause are associated with weight gain, increased abdominal fat (central adiposity), and decreased physical activity for many women but causes remain controversial. The etiology of perimenopausal obesity is complex and not fully understood. It remains unclear whether excessive weight gain and changes of fat distribution at menopausal age result from the hormonal changes that occur in this transition period or are related to the normal process of aging. Simkin-Silverman & Wing (2000) state that while weight change occurs independent of menopausal status, adverse changes in body fat distribution and body composition may be due to hormonal changes occurring during the menopausal transition. Although hormone replacement therapy (HRT) use is widely believed to cause weight gain, data from the PEPI trial (Stefanick 1999) and others (Bjorkelund et al 1996) do not support this belief. Moreover, though HRT may have a protective effect in reducing central adiposity, the consensus may be that potential risks associated with HRT outweigh its benefits (Beral et al 2003). In a longitudinal, observational study of the menopausal transition amongst racially/ethnically diverse women, change in menopausal status was not associated with weight gain or significantly associated with increases in waist circumference (Sternfeld et al 2004). Data from Wing et al (1991) and Lanska et al (1985) agree. Other studies (Ijuin et al 1999, Bjorkelund et al 1996, Panotopoulos et al 1996) that do report a menopause related effect on weight gain and fat distribution may not be adequately controlled and have not adequately represented obese women. Matthews et al (2001) concluded that menopausal status and age were much less powerful predictors of increased BMI than physical activity and ethnicity.

## Obesity and reproductive cancers

### *Overview*

- Weight gain during adulthood and postmenopausal obesity increase breast cancer risk and mortality. Further studies are needed in minority women.
- Obesity has been consistently associated with uterine (endometrial) cancer.
- It is unclear whether obesity affects ovarian or cervical cancer risk.
- Most studies conclude that there is no association of obesity with prostate cancer risk.

The National Cancer Institute (2004) has an extensive consensus review on current research and its main points concerning reproductive cancers are summarized below.

### Obesity and breast cancer

The effect of obesity on breast cancer risk depends on a woman's menopausal status. Before menopause, obese women have a lower risk of developing breast cancer than do women of a healthy weight. However, after menopause, obese women have 1.5 times the risk of women of a healthy weight. Obese women are also at increased risk of dying from breast cancer after menopause compared with lean women. This is because the detection of a breast tumor is more difficult and detected at a later stage in obese versus lean women. This could also account for the reduced detection before menopause.

The NCI review states that both the increased risk of developing breast cancer and dying from it after menopause are believed to be due to increased levels of estrogen in obese women. Before menopause, the ovaries are the primary source of estrogen. However, estrogen is also produced in fat tissue and, after menopause, when the ovaries stop producing hormones, fat tissue becomes the most important estrogen source. Estrogen levels (mainly estrone rather than estradiol) in postmenopausal women are 50 to 100 percent higher among heavy versus lean women (Hankinson et al 1995). Estrogen-sensitive tissues are therefore exposed to more estrogen stimulation in heavy women, leading to a more rapid growth of estrogen-responsive breast tumors.

Obesity seems to increase the risk of breast cancer only among postmenopausal women who do not use menopausal hormones (Morimoto et al 2002 and other studies). Among women who use menopausal hormones, there is no significant difference in breast cancer risk between obese women and women of a healthy weight.

Weight gain during adulthood has been found to be the most consistent and strongest predictor (more so than BMI) of breast cancer risk in studies in which it has been examined. Conversely, weight loss has been found to decrease risk. The distribution of body fat may also affect breast cancer risk. Women with a large amount of abdominal fat have a greater breast cancer risk than those whose fat is distributed over the hips, buttocks, and lower extremities. Abdominal fat is associated with increased androgens in women and altered lipid and insulin metabolism. Results from studies on the effect of abdominal fat are much less consistent than studies on weight gain or BMI.

The NCI review states that studies of obesity and breast cancer in minority women in the United States have been limited. There is some evidence that, among African American women, the risk of breast cancer associated with obesity may be absent or less than that of other populations. However, a recent report showed that African American women who have a high BMI are more likely to have an

advanced stage of breast cancer at diagnosis (Cui et al 2002), both obesity and race being significant factors. Zhu et al (2005) suggest that BMI at diagnosis and the increase in BMI since age 18 were associated with increased risk of breast cancer in African American women, and the association might be found for both post-menopausal and pre-menopausal tumors. Another report showed that obese Hispanic white women were twice as likely to develop breast cancer compared to non-obese Hispanic women, but the researchers did not detect a difference in risk for obese Hispanic women before and after menopause (Wenten et al 2002).

#### Obesity and cancer of the uterus

Obesity has been consistently associated with uterine (endometrial) cancer. Obese women have two to four times greater risk of developing the disease than do women of a healthy weight (BMI<25), regardless of menopausal status. Increased risk has also been demonstrated among overweight women. Obesity has been estimated to account for about 40 percent of endometrial cancer cases in affluent societies. It is unclear why obesity is a risk factor for endometrial cancer; however, it has been suggested that high levels of estrogen and insulin in obese women, as well as dietary intake of fat may be contributing factors (Goodman et al 1997).

#### Obesity and cancer of the ovary

It is unclear whether obesity affects ovarian cancer risk. Some studies report an increased risk among obese women, whereas others have found no association. A recent report found an increased risk in women who were overweight or obese in adolescence or young adulthood; no increased risk was found in older obese women (Engeland et al 2003). Fairfield et al (2002) also found no evidence of an association between obesity, recent BMI or adult weight change and ovarian cancer risk. Higher BMI (>25) in young adulthood was associated with an increased risk of premenopausal ovarian cancer. These authors suggest that the association of obesity with increased ovarian cancer risk in some studies may be mediated by greater exposure to endogenous androgens associated with obesity. In addition, adult weight gain and obesity in the postmenopausal period increase levels of endogenous estrogens. The relationship between postmenopausal estrogens and ovarian cancer is unclear. Higher serum estrogens could act in ovarian cancer promotion, or alternatively could decrease gonadotropin release, in turn decreasing ovarian cancer risk. Oral contraceptives decrease ovarian and endometrial cancer risk, perhaps because of interactions with endogenous androgens.

#### Obesity and cancer of the cervix

The NCI in its current review of cervical cancer prevention makes no mention of obesity being associated with altered risk.

#### Obesity and cancer of the prostate

Of the more than 35 studies on prostate cancer risk, most conclude that there is no association with obesity. Some studies report that obese men are at higher risk than men of healthy weight, particularly for more aggressive tumors. A recent study suggested that obesity may lower prostate-specific antigen levels, affecting the predictability of the screening test (Baillargeon et al 2005). Studies examining BMI and prostate cancer mortality have had conflicting results; some finding that obesity increases prostate cancer mortality and others finding no association.

### **Obesity, psychosocial issues and sexual functioning**

Though beyond the scope of this review, there is a large body of published research and writing on body weight and its connections with body image, relationship satisfaction and self-efficacy. Examples range from social psychology (Susie Orbach's 'Fat is a Feminist Issue') to studies in African-American

women that have shown an association between body image dissatisfaction, obesity risk, and greater risk of unintended pregnancy and STD (Wingood 2002). Another example of clinical research has shown that lifestyle modification through diet and exercise programs in obese subjects with PCOS improves psychological parameters (self-esteem, anxiety, depression scores and general health scores) in addition to reproductive outcomes (Norman et al 2004).

Obesity and sexual dysfunction in men and women is also a topical subject, not least because of ubiquitous advertising for pharmacological treatments. In the Massachusetts Male Aging Study of men aged 40 to 69, erectile dysfunction affected nearly half of all obese individuals, being nearly three times more common than in non-obese individuals (Trischitta 2003). Mechanisms through which obesity may affect sexual dysfunction include reduced androgen levels, insulin resistance and associated hormonal changes, dyslipidemia and related drugs and psychological problems (see Trischitta 2003 for review). No firm data are available about the epidemiology of sexual dysfunction among obese women.

### **Obesity and reproductive health – summary and conclusions**

#### Clinical guidelines on assessment and treatment of overweight and obesity.

Four recent publications (NIH 2001, McTigue et al 2003, Jain 2004, Avenell et al 2004,) have made systematic reviews of research and findings on successful treatments for obesity and the areas where further research is needed. None have focused on the reproductive context but all make similar recommendations. The NIH clinical guidelines include an assessment and treatment algorithm (see Appendix, Figure 1). In summary, NIH assessment guidelines suggest that as well as BMI and waist circumference measurement, consideration should be made of current disease conditions and other risk factors (e.g. diabetes and CVD indicators) as well as patient motivation for weight loss and maintenance. The initial goal of weight loss is 10 percent over six months. NIH treatment guidelines suggest that a combination of a reduced calorie diet and increased physical activity provides the most successful therapy for weight loss and maintenance. Behavioral therapy is a useful adjunct, at least in the short term (1 year). The goal of behavioral therapy is to alter the long-term eating and activity habits of the patient and provide methods to overcome barriers that prevent patients from following diet and physical activity goals. Pharmacological treatment of obesity should be considered only as part of a program that also includes diet and exercise interventions. Orlistat and sibutramine, two medications that have been approved for weight loss by the Food and Drug Administration, can produce modest weight loss, but adverse effects are frequent and there are no data on the long-term (longer than 2 years) benefits or harms of these drugs. Lost weight will usually be regained unless a weight maintenance program with professional supervision is continued indefinitely.

The NIH 2001 review states that weight loss reduces blood pressure in both overweight hypertensive and normotensive individuals, reduces serum triglycerides and low-density lipoprotein cholesterol and increases high-density lipoprotein cholesterol. Weight loss reduces blood glucose levels in overweight and obese persons without diabetes and reduces blood glucose levels and HbA1c in some patients with Type 2 diabetes.

In the obese patient who smokes, smoking cessation is a major goal to reduce risk factors. Attendant weight gain is observed in 80 percent of quitters, averages 7lb (but exceeds 28lb in 13 percent of women) and is quite resistant to most interventions. The weight gained is less likely to produce negative health consequences than would continued smoking. The NIH 2001 review suggests it may be prudent to manage smoking cessation and weight loss sequentially.

A recent review (Reaven et al 2004) stated that it is necessary to differentiate between the CVD risk related to obesity per se, as distinct from the fact that the prevalence of insulin resistance and associated metabolic abnormalities (themselves independent risk factors for CVD) are increased in overweight/obese individuals. Although the majority of those considered insulin resistant are also overweight/obese, not all overweight/obese persons are insulin resistant. (Similarly, PHMC (2002) data below shows that although 48% of diabetic adults are obese, only 16% of obese adults are diabetic). It seems essential (Reaven et al 2004) to identify those overweight/obese individuals who are also insulin resistant (and at increased CVD risk) and target those with what is known as the Metabolic Syndrome for the most-intensive efforts to bring about weight loss and metabolic readjustment. Diagnostic criteria are given in a recent review (Wong 2005) and include abdominal obesity, an abnormal lipid profile and elevated blood pressure and fasting glucose.

#### Sexual maturation: intervention studies and implications

There is clear evidence that increased obesity and earlier sexual maturation are associated but causal evidence that obesity influences sexual maturation, or that sexual maturation independently affects obesity is inconclusive in both girls and boys.

Approaches to childhood obesity prevention, evaluation and treatment are rarely evidenced-based because so few studies have been performed (Barlow & Dietz 1998). A survey (Barlow et al 2002) of interventions used by healthcare providers showed that they generally promoted healthy eating and activity with minimal use of highly restrictive diets or medication to control weight. Providers frequently expressed a need for guidance and strategies that motivate patients and families to make and maintain behavioral changes. Recent Cochrane Database reviews (Campbell et al 2002, Summerbell et al 2003) report limited data on effectiveness of programs to prevent or treat childhood obesity and no conclusions can be drawn. A number of prevention studies are underway. For primary care clinicians, though it may be useful to arrange dietary (and physical activity) counseling for obese early-pubertal girls, there are no data to indicate that slowing or stopping their weight gain would slow or arrest the progression of puberty (Kaplowitz et al 2001). Recent Expert Committee recommendations (Barlow & Dietz 1998) on obesity treatment make no mention of early sexual maturation as a related condition.

#### Contraception: implications for practice

There is evidence for some effect of obesity on the effectiveness of the combined contraceptive hormonal patch but inconclusive evidence for combined OC. Evidence for effects of obesity on other common methods is lacking or negative. Regardless of weight, hormonal contraception remains very effective at preventing pregnancy.

Because of some studies that suggest reduced effectiveness of combined OC and the patch in obese women, the question arises as to whether there is a need to reassess recommending higher dose OC for overweight/obese women. A risk-benefit assessment would suggest no. Overweight women are already at higher risk of venous thrombosis and cardiovascular disease (CVD). OC are associated with a two to ten fold increase in risks of CVD and venous thrombosis in overweight and obese women (Nightingale et al 2000, Abdollahi et al 2003) and the risk increases with estrogen dose (Lidegaard et al 2002). There are no data to suggest that the contraceptive patch behaves differently from OC. Mansour (2004) in the UK suggests that a BMI >35 absolutely contraindicates OC and that caution and alternative methods should be counseled to women with BMI >30. Hatcher and Guillebaud (1998) state that "a young obese women can be started on low-dose OC but OC might be avoided in women over 35 who are very overweight. The pill's protective effect against endometrial cancer may be desirable in overweight women, whose risk of endometrial cancer is increased. There is no evidence that overweight women need a higher-dose OC for better effectiveness". Hatcher and Nelson (2004) give

no recommendation regarding obesity but quotes the current World Health Organization eligibility criteria (WHO 2004) that suggest that obese women generally may use OC since advantages associated with pregnancy prevention outweigh risks. American College of Obstetrics and Gynecology practice guidelines on this topic would be of benefit to clinical providers.

More research is needed to determine the effect of combined hormonal contraceptives on weight and it would be worthwhile to include subjects across the whole spectrum of body weights in these studies. Only Depo-Provera has been shown to contribute significantly to weight gain. It is clearly an unpopular side effect that reduces continuation with this method. Further long-term studies of both the extent of the weight gain and whether this will cause health problems in already overweight and obese women are warranted. Studies of interventions that may reduce weight gain in obese women on Depo-Provera and improve weight loss when the method is discontinued would be worthwhile. More data on overweight and obese women would assist presentation of risks and benefits for normal and overweight women to better balance the (hopefully) temporary weight gain from Depo-Provera against the effectiveness and utility of the method. Mansour (2004) states that there are no data to suggest that obese women using progestin-only contraceptives (see Table 1) faced increased risk of adverse effects from cardiovascular disease (CVD).

### Infertility

Obesity is associated with menstrual disorders and infertility. Substantial weight loss, though desirable, is not essential for successful restoration of reproductive function. Reduction of insulin resistance is most closely correlated with returned fertility. Following assessment of infertility and obesity, various weight management interventions, including diet, exercise or pharmacotherapeutic approaches (favoring weight loss and improving insulin resistance), should be considered for overweight and obese infertile women. Pasquali et al (2003) and Norman et al (2004) have extensive reviews of interventions and outcomes. Lifestyle modification through diet and exercise programs in obese subjects with Polycystic Ovarian Syndrome improves psychological parameters (self-esteem, anxiety, depression scores and general health scores) in addition to reproductive outcomes (Norman et al 2004).

### Intervention studies during pregnancy and post-partum.

There is clear evidence that maternal obesity negatively impacts the mother (during the pregnancy and long-term) as well as the outcome for the infant. Maternal obesity increases lactation failure and post-partum anemia.

In general an important aspect of antenatal care is that nutrition assessment and intervention with modification of dietary and activity patterns can modulate weight gain, improving pregnancy outcome. Weight reduction during pregnancy is not recommended but should be emphasized in pre-pregnancy counseling (Mitchell 2003). A recent study showed that a randomized controlled behavioral intervention reduced excessive weight gain during pregnancy among normal weight women but not among overweight women (Polley et al 2002). There is a need for a meta-analysis to identify successful programs among obese women (Rossner 1999). Failure to lose weight after pregnancy is a predictor of subsequent long-term weight gain (Rooney and Shauberg 2002) that can be reduced by breast-feeding and postpartum exercise. Research is needed on racial/ethnic subgroups most at risk for obesity (Rosenberg et al 2003) and increased post-partum weight retention (Parker and Abrams 1993).

### Menopause

There is some evidence for earlier menopausal onset and increased symptoms in overweight/obese women but the physiological explanations are unclear. The balance of evidence favors no menopause

related effect on weight gain in addition to age-related changes in diet and exercise but studies on obese women are lacking.

Data from Study of Women's Health Across the Nation and the Women's Healthy Lifestyle Project provide clear evidence that weight gain and increased waist circumference, along with elevations in lipid levels and other CVD risk factors, are preventable through use of long-term lifestyle dietary and physical activity intervention in healthy women during the peri- to postmenopause. (Simkin-Silverman et al 2003).

#### Family planning and obesity – implications for practice.

In addition to health benefits for family planning consumers, addressing weight-related health issues such as obesity has immediate implications for the family planning system including:

1. Linking obese family planning consumers to primary care for further evaluation and medical management
2. Improving pre-conception health of women thus reducing health risks to mother and baby in the prenatal and antenatal periods
3. Assessing and supporting weight reduction and weight management of women during the post-partum period
4. Minimizing pregnancy-risk by addressing women's concerns of actual or perceived weight gain as a side effect of contraceptive use.

The long-term benefits for the nation's public health system include:

1. Intervening with young adults early enough to educate, remediate, and establish improved nutrition and physical activity
2. Early identification of health-risks and referral to care, forestalling onset of more serious, and unmonitored health conditions

Family planning providers have substantial experience and expertise providing counseling and education on healthy behaviors and behavior change. They are interacting with women at points in their life that may be especially opportune for nutritional and weight management messages that could also emphasize fitness and lifestyle changes. As evidenced in this review, there are immediate benefits for overweight/obese women to improve nutrition and physical activity in their reproductive years. Young women in general are critical to reach, as lifestyle habits, including smoking, diet and exercise, are often formed early in life and may be difficult to change later. Because a central family planning service is preconception counseling and education, women in family planning clinics who are considering pregnancy can be encouraged, if necessary, to alter their behavior in advance of becoming pregnant so as to encourage the best possible health outcomes for themselves and their infants. Postpartum visits are also opportunities for addressing weight related concerns of clients.

Family Planning patients undergo an assessment and education process as new patients and at annual exams. At these visits, data are obtained on blood pressure and height and weight (in some instances BMI is calculated). What are the current methods being used to identify patients who are overweight or obese? What clinical tests and assessment questions are in place that can identify individuals who are at risk for diabetes and CVD? When these individuals are identified as having high blood pressure and high BMI, what are the current follow up methods? What methods are used to educate and refer consumers to primary health care for screening tests for diabetes and CVD (e.g. cholesterol and lipids)? How does identifying individuals who are at risk for these diseases fit within the context of how Title X clinics are currently screening and referring patients for various vital health and social service needs (i.e. domestic violence, mental health, primary care)? How do these assessment,

education, and clinical methods relate to women versus men or to women who are pregnant? For those who are not pregnant, should Title X clinics, at a minimum, provide information on nutrition and physical activity to all women and men who present with BMI in the overweight and obese range? Should there be a Standard Operating Procedure for providers on these issues for patients with a BMI of 25 or greater? If so, how might family planning providers use resources that are already available such as the clinical guidelines and treatment algorithm for overweight and obesity referred to earlier in the summary section (NIH 2001) as well as the revised 'Dietary Guidelines for Americans' (DHHS 2005) which have a heightened focus on physical activity and calorie control.

However there are barriers to moving forward with addressing weight-related risk factors in family planning. There are no proven models for successful approaches to address weight management issues in the context of public reproductive health care. And if there were, family planning providers may have a lack of knowledge, training or enthusiasm (perhaps in implementing behavioral interventions for which they have concerns themselves). Even a short counseling intervention may seem too long to add into a family planning visit, particularly when this is not the presenting concern for the client. Another concern is that a poorly tailored message has the potential to label, alienate or lead to harmful outcomes for patients. Interventions should be conscious of an antiobesity message's possible impact on body image, including the danger of eating disorders and of increased smoking, which is sometimes used as a tool for staying slim (Alan Guttmacher Institute, 2003). Lack of reimbursement may be the most serious barrier, however. State Medicaid programs typically exclude coverage for obesity related services, including drugs for weight loss (American Obesity Association) and fees for fitness activities. The extent to which new federal funding for antiobesity programs will materialize remains to be seen but family planning providers would be well situated to make valuable contributions to these efforts.

## Appendix

### The obesity epidemic in the USA, Region III and in Southeastern Pennsylvania.

National data on overweight and obesity prevalence are available from the CDC National Health and Nutrition Examination Survey (NHANES). Further breakdown by gender, age, race, and Hispanic origin is available.

Table 4. National prevalence of overweight and obesity (%) in adult men and women (NHANES).

|       |            | 1988-1994 | 1999-2002 | % change between surveys |
|-------|------------|-----------|-----------|--------------------------|
| Men   | obesity    | 21        | 28        | 36                       |
| Men   | overweight | 40        | 41        | 1                        |
| Women | obesity    | 26        | 34        | 31                       |
| Women | overweight | 25        | 28        | 10                       |

Table 5. National prevalence of overweight and obesity (%) in adult women (NHANES 1999-2002).

|                             | obesity | overweight | healthy |
|-----------------------------|---------|------------|---------|
| Non-hispanic white, 20-74yr | 31      | 26         | 40      |
| Non-hispanic black, 20-74yr | 50      | 28         | 21      |
| Hispanic, 20-74             | 39      | 33         | 28      |
| 20-34, all races            | 28      | 24         | 43      |
| 35-44, all races            | 32      | 29         | 37      |

Regional (self-report) data on overweight and obesity prevalence are available from the CDC Behavioral Risk Factor Surveillance System (BRFSS) and confirm the striking increase in obesity prevalence amongst adult women and men in the five states and the District of Columbia that comprise Region III as well as the current uniformity of overweight and obesity across the Region.

In Southeastern Pennsylvania, self-report data (PHMC 2002) are available to analyze the prevalence in more detail. These show that 36% of all adults (>17 years of age) are overweight (BMI between 25 and 29.9) and that 23% of all adults are obese (BMI>30). The percentage of obese adults in Southeastern Pennsylvania is higher than the Healthy People 2010 objective of no more than 15% of adults considered obese. Some population groups are more likely to be obese than are others. Adults aged 40 to 59 (26%) and adults aged 60 and older (25%) are more likely to be obese compared to adults 18 to 39 (18%). Women overall are only slightly more likely to be obese (23%) compared to men (22%). Black adults in Southeastern Pennsylvania are more likely to be obese (36%) compared to white adults (20%). More Latino adults are obese (26%) compared to non-Latino adults (22%). Low-income adults are more likely to be obese (33%) compared to high-income adults (21%). Those with less than a high school education were more likely to be obese (31%) than college graduates (17%). Thirty eight percent of children in Southeastern Pennsylvania are at risk for obesity (BMI>85 percentile). Young children (aged 10 or younger) are twice as likely (50%) to be at risk for obesity than those aged 11 to 17 (26%). Other groups at greater risk are boys (42% versus 34% for girls), and Black and Latino children.

In Southeastern Pennsylvania, combined data (PHMC 2002) from men and women show that 38% of obese adults and 17% of obese children have a chronic health condition. Forty seven percent of obese adults have high blood pressure, 33% have high cholesterol and obese adults are twice as likely as normal to have a heart condition or asthma. Obese adults are five times as likely to be diabetic (16%) compared to adults who are of normal weight (3%). In Southeastern Pennsylvania, data show that the

prevalence of diabetes among all adults has nearly doubled in the past decade, increasing from 4.1% in 1991 to 7.7% in 2002. Nearly half (48%) of all adults with diabetes are obese (BMI >30) compared to one out of five adults without diabetes (20%).

### Terminology.

BMI is calculated by body weight (kg)/height (m)<sup>2</sup> or by body weight (lb)/height (inches)<sup>2</sup> \*703. For adult men and women, obesity is defined as a BMI of 30 kg/m<sup>2</sup> or greater; those with BMI between 25 and 29.9 are considered overweight and a BMI between 18.5 and 24.9 is considered healthy. A BMI of 30 is equivalent to 180lb in a woman 65 inches tall and is 30lb overweight (compared to BMI 24.9 of same height). For children, BMI between 85<sup>th</sup> and 95<sup>th</sup> percentile for age and sex is considered at 'risk of overweight' and BMI at or above the 95<sup>th</sup> percentile is considered 'overweight or obese' (Krebs et al 2003). Waist circumference is positively correlated with abdominal fat content and the presence of excess fat in the abdomen out of proportion to total body fat is an independent predictor of risk factors and morbidity. Waist circumference cutoffs for increased risk are >35 inches in women and >40 inches in men.

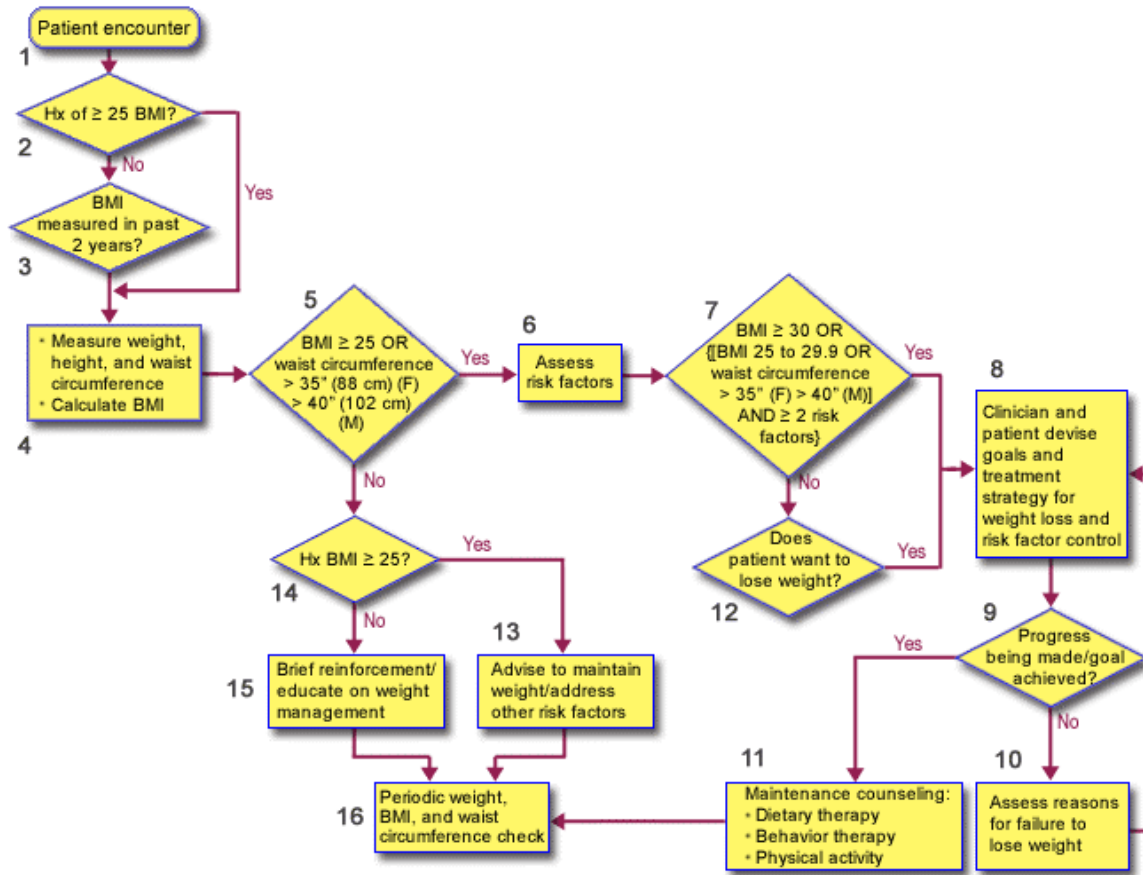
A literature review is challenged by the variety of terminology used by its constituent papers and thereby embraces some ambiguity. Where BMI is given, 'obese' and 'overweight' have been indicated in accordance with definitions above. With studies of children, 'overweight' and 'obese' are used interchangeably since no defined criteria exist to make a distinction (Barlow & Dietz 1998). In adults, 'overweight' as defined above does denote a lower % body fat than 'obese', based on body composition analysis that measures percent and absolute body fat by a variety of different methods. BMI correlates well with body fat but includes lean body mass. BMI may be used as a surrogate for adiposity, another term used to describe body fat. Adiposity itself in some studies may be assessed by skinfold thickness, rather than by body composition. Furthermore some authors may refer to fatness but it may be unclear whether fatness refers to body fat (absolute weight) or to body fat (proportion). Ambiguities also arise in interpretation of research studies when investigators give only body weight and not height, discuss overweight when they mean obese (or vice-versa) without being precise about the definition or draw conclusions about associations with body weight or BMI from studies that include few obese subjects.

Jain (2004) and Zukoski et al (2004) give a useful summary of the criteria for appraising research studies and the value of randomized clinical trials.

### Sex steroid physiology

Sex steroid hormones - testosterone (the principal male hormone) and estradiol (the principal female hormone) - are secreted by the testes and ovaries respectively. Sex hormone binding globulin binds most androgens and estrogens in the blood but levels of un-bound (free) testosterone and estradiol sustain reproductive function. Sex steroid hormones also accumulate in body fat. Adipose cells (fat cells) convert the weak androgen, androstenedione, to the weak female hormone, estrone (Whittaker 1986). Estrone, though not as potent as estradiol, has metabolic effects on the hypothalamic-pituitary axis of the brain (the area of the brain that regulates testicular and ovarian function) to alter reproductive function. Obese women progressively increase their alternate estrogens - estrone and estriol (a metabolite of estradiol) - and develop irregular reproductive cycles and anovulation. These effects of body weight on female reproductive function are well established. However, the effects of body weight on male reproductive function are not well studied and are more speculative.

**Figure 1.** Assessment and Treatment algorithm (NIH 2001)  
 Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults.



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