DIETARY INTAKE AND FOOD CRAVING DURING NORMAL MENSTRUAL CYCLING

A thesis submitted to the Kent State University College of Education, Health, and Human Services in partial fulfillment of the requirements for the degree of Masters of Science

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The purpose of this study was to measure dietary changes and food craving between different phases of the menstrual cycle in normal menstruating women attending Kent State University in Kent Ohio. It was hypothesized that there is a change in dietary intake during the menstrual cycle, and women experience food cravings during the menstrual cycle. Data collection was divided into two main stages. First, the pre-assessment stage where data from (N=60) women were collected using online survey that contains four sections: Health History Questionnaire, Eating Attitude Test-26 (EAT-26), The Mental and Physical Symptom Daily Rating Scale, and Food Craving Questionnaire. Based on the result of the first stage, eligible participants were allowed to continue to the second stage, the assessment phase (n=18), where the cycle was divided into three main phases (menstrual, follicular, ad luteal) and six measurement methods were used: The menstrual cycle tracking record, the ovulation test to measure Luteinizing hormone (LH) surge, Food Record, Craving Screening, Food Craving Record, Mental and Physical Symptom Daily Rating Scale. The data was entered by the Kent State University Research Bureau using the social science (SPSS, version 21) and significant level of (p≤0.05). Statistical methods included descriptive statistics, Simple Analysis of Variance (ANOVA), and Repeated Measures Analysis of Variance (RM ANOVA). Result: there were no significant differences in dietary intake, energy and macronutrients
(carbohydrate, protein, and fat), during the three phases of the normal menstrual cycle. On the other hand, food cravings results indicated that food craving exists during menstrual cycle in normal menstruating women, during the three phases, and was not significantly related to specific phase. Further studies are needed to examine the dietary behaviors of women during different phases of the cycle. The type of the craved foods needs to be analyzed and measured in correlation with the severity of food restriction.
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CHAPTER I

INTRODUCTION

Each month, women during the reproductive age will have a menstrual cycle (Goodman, 2003; Levy & Lightman, 1997) that lasts 28 days on average (Carr & Blackwell, 1993; Barbieri, Jaffe & Yen, 1999; Silberstein & Merriam, 2000). During the menstrual cycle, women’s body will experience physiological and psychological fluctuations due to hormonal changes in the body (Rapkin, 2003) this might have a great impact on the quality and quantity of the food consumed, therefore, the regular diet will be imbalanced. Approximately 74 percent of women experience food cravings during the menstrual cycle (Dye, Warner & Bancroft, 1995).

Menstruation is known as the process of losing blood from the uterus each month during reproductive age (Goodman, 2003; Levy & Lightman, 1997). Each menstrual cycle consists of three main phases: follicular, luteal, and menstrual phase (Jones, 1991; Henriet, Gaide Chevronnay & Findlay, 1999). The follicular phase occurs in the first half of the cycle (Barbieri, Jaffe & Yen, 1999) and varies in length between 10 to 16 days (Levy & Lightman, 1997). The Luteal phase begins with ovulation and ends on the first day of the menstrual phase (Owen, 1975; Croxatto, 2008). Lastly, the menstrual phase starts with the end of the luteal phase and lasts for 4 ±2 days (Levy & Lightman, 1997). Normal reproductive function and menstrual cycle require organized work between hypothalamus which produces gonadotropin -releasing hormones (GnRH), pituitary gland which produces leutinizing hormone (LH) and follicular stimulating hormone
(FSH), and the ovaries which produce steroids, estrogen and progesterone (Silberstein & Merriam, 2000).

Balanced and healthy diet is essential to maintain healthy body weight. However, many researchers found that appetite and dietary intake are affected during different phases of the menstrual cycle (Dye & Blundell, 1997). Essentially, the proposed cause of changing dietary intake was hormonal fluctuations, primarily estrogen and progesterone (Howe, Rumpler & Seale, 1993). The elevation in progesterone level during the luteal phase was found to be associated with an increase in food intake, while elevation estrogen level during the follicular phase was found to be associated with decrease food intake (Dalvit-McPhillips, 1983; Johnson, Corrigan, Lemmon, Bergeron & Crusco, 1994; Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988).

The dietary intake was studied by many researchers and measured by analyzing the macronutrients intake (carbohydrate, fat, and protein) and the total energy intake throughout various phases of the menstrual cycle (Tarasuk & Beaton, 1991; Lyons, Truswell, Mira, Vizzard & Abraham, 1989; Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988; Gong, Garrel & Calloway, 1989). The common findings among these studies were an increase in dietary consumption during the luteal phase when compared to the menstrual and the follicular phase.

In addition to measuring the amount and types of different macronutrients during menstrual cycle phases, the cravings of food were investigated by measuring the intensity rate and type of food items that is craved. Many opinions have been proposed about the food craving phenomenon, some researchers considered the process of food craving to be
a response from the women’s body to the increase level of energy expenditure or to dietary deficiency (Yen et al., 2010), while others associated it to hormonal and psychological changes during menstrual cycle (Cohen, Sherwin, Fleming, 1987), though, Rabinovitz (2005) suggested that craving for particular food is mainly results from psychological purpose to relief intense desire for that food in addition to stress or tension. Moreover, several studies have linked the episodes of food craving during the menstrual cycle with psychological conditions such as depression, premenstrual syndrome (PMS), and premenstrual dysphoric disorder (PMDD) (Dye, Warner & Bancroft, 1995; Yen, Chang, Ko, Yen, Chen, Yeh & Chen, 2010; Smith & Sauder, 1969). Comparing to the menstrual and follicular phase, the luteal phase tend to have the highest craving episodes, and chocolate was found to be among the most craved food items (Hill & Heaton-Brown, 1994; Hormes & Timko, 2011). During the menstrual cycle, women who have high craving episodes found to have low control of body weight and feeling of guilt associated with the craving process (Hormes & Timko, 2011).

**Problem Statement**

Women during reproductive age will experience monthly menstrual cycles (Goodman, 2003; Levy & Lightman, 1997). During each menstrual cycle, psychological, physiological, and hormonal changes will happen (Rapkin, 2003). As a result, the dietary pattern of women may be affected. Many studies have measured the dietary intake of women during menstrual cycle and found significant increase during the luteal phase of the cycle, and this change was proposed to be a result of hormonal changes (Dalvit-McPhillips, 1983; Johnson, Corrigan, Lemmon, Bergeron & Crusco, 1994; Lissner,
Stevens, Levitsky, Rasmussen & Strupp, 1988), or it was connected it to depression and PMS (Wurtman, Brzezinski, Wurtman & Laferre, 1989).

In addition to dietary intake, food craving during the menstrual cycle was investigated by several researchers. In general, women tend to experience food cravings more than men throughout their life due to various physiological and psychological conditions (Hill & Heaton-Brown, 1994). Many literatures associate the food craving phenomenon during the menstrual cycle with several factors such as depression, PMS (Dye, Warner & Bancroft, 1995; Yen, Chang, Ko, Yen, Chen, Yeh & Chen, 2010; Smith & Sauder, 1969), anxiety and negative mood (Hill, Weaver & Blundell, 1991), dietary restrictions, and eating disorders (Gendall, Sullivan, Joyce & Bulik, 1997). Many undesirable consequences of food cravings have been reported such as feelings of guilt, weight fluctuation (Hormes & Timko, 2011), it might initiate binge eating and consequently lead to Bulimia (Waters, Hill & Waller, 2001), or it might lead to addiction of the craved food item (West, 1987).

There are several studies linked the fluctuation in dietary intake with hormonal changes, and other studies linked the food carving episodes with the psychological changes during the menstrual cycle. Consequently, the quantity and quality of diet are affected, and difficulties in maintaining normal body weight might happen, which lead to monthly imbalance of women’s dietary habits. Therefore, it is essential to consider and investigate the variation in dietary changes and food cravings during the menstrual cycle.
Purpose Statement

The purpose of this study is to determine if dietary changes and food cravings occur during the menstrual cycle.

Hypothesis

H1: There is a change in dietary intake during the menstrual cycle

H2: Women experience food cravings during the menstrual cycle.

Operational Definitions

- Women: healthy women during reproductive age, 18 to 40 years old, who have regular menstrual cycles and do not complain of any illness and do not use oral contraceptives or medications.

- Regular menstrual cycle: occurs every month (25 to 35 days) and consists of 3 phases: menstrual, follicular, and luteal. The menstrual phase lasts for 4 ±2 days, the follicular phase lasts for 10 to 16 days, and the luteal phase which lasts for 14 days (Levy & Lightman, 1997).

- Dietary intake: the daily consumption of food and drinks, (Carbohydrates “g”, fat “g”, protein “g”, and total energy “Kcal”).

- Food craving: Craving is “increase desire to a particular substance” (Weingarten & Elston, 1990).
CHAPTER II
REVIEW OF LITERATURE

Menstrual Cycle

Losing blood from the uterus at monthly interval is known as “Menstruation” (Goodman, 2003; Levy & Lightman, 1997). The menstrual discharge composed of blood and fluids secreted from the vagina and other fluid secreted in the last stage of menstruation when the endometrial lining shed from the uterus (Jakubowsk, Maciejewska, Bielawski & Pawłowski, 2014). Once the bleeding occurred, it is clinically considered as the first day of the menstrual cycle (Barbieri, Jaffe & Yen, 1999; Jones, 1991). The word “Menstrual” is derived from “Menses” which is a Latin word that means “month”, because each cycle takes about 29.5 days to be completed (Jones, 1991). However, this duration of the menstrual cycle applied for only 10 to 15 percent of women (Jones, 1991), and most cycle’s length has ranged from 25 to 30 days with an average of 28 days (Carr & Blackwell, 1993; Barbieri, Jaffe & Yen, 1999; Silberstein & Merriam, 2000). The length of the menstrual cycle is measured from the beginning of bleeding until the first day of bleeding of the next proceeding cycle (Carr & Blackwell, 1993; Barbieri, Jaffe & Yen, 1999). The menstrual cycle will proceed every month at the reproductive age, except during periods of pregnancies and lactations (Goodman, 2003; Levy & Lightman, 1997), and when the menopause phase begins around the age of 51, which will be the end of the menstrual cycle (Goodman, 2003; Levy & Lightman, 1997). Although the median period between each cycle is about 28 days (Carr & Blackwell,
1993; Barbieri, Jaffe & Yen, 1999; Levy & Lightman, 1997), there is a variation at the beginning and the end of the reproductive age of the women, during periods of adolescence and menopause transition which will result in increasing the frequencies of anovulatory cycles (Barbieri, Jaffe & Yen, 1999; Jones, 1991). The rise in estradiol and gonadotropin secretion lead to luteal phase defect or anovulatory cycles, and this will increase the length of the interval between the cycles (Barbieri, Jaffe & Yen, 1999).

When the hypothalamic, pituitary, and ovarian system interact with the target tissues in the female’s genital tract - uterus, oviduct, endometrium, and vagina- this interaction will result in menstruation (Barbieri, Jaffe & Yen, 1999; Carr & Blackwell, 1993). Each menstrual cycle consists of three main phases (Jones, 1991; Henriet, Gaide Chevronnay & Findlay, 1999), as shown on figure 1 (Farage, Osborn & MacLean2008):

- The menstrual phase, which lasts for 4 ±2 days
- The follicle (proliferative/estrogenic) phase which has a varying length between 10 to 16 days
- The luteal (secretory/progestational) phase which lasts for a constant 14 days (Levy & Lightman, 1997)

**Menarche**

Menarche is defined as the first menstrual period (Levy & Lightman, 1997; Goodman, 2003). It is a sign of pubertal maturation and development in female (Barbieri, Jaffe & Yen, 1999). The first year of menarche is characterized by irregular cycle length because of the unsynchronized hypothalamic-pituitary-ovarian axis that causes anovulatory cycles (Barbieri, Jaffe & Yen, 1999). The age of the menarche onset is between nine and 16 years (Barbieri, Jaffe & Yen, 1999), with an average age of 13 years (Levy & Lightman, 1997; Goodman, 2003). The mean age of menarche when measured...
for 371 females in a longitudinal study was 12.75 years (Towne, Czerwinski, Demerath, Blangero, Roche & Siervogel, 2005).

There are many factors that influence the process of menarche development of the female, such as genetic and environmental factors (Karapanou & Papadimitriou, 2010; Freedman, Khan, Serdula, Dietz, Srinivasan & Berenson, 2002). Mother and daughter age at menarche are usually measured to determine the influence of genetics on menarcheal age, however, it was also suggested that because of shared environmental factors between the mother and daughter, this causes a strong association and similarities at menarcheal age (Freedman, Khan, Serdula, Dietz, Srinivasan & Berenson, 2002). Ethnic and racial variations are also important factors in determining the onset of menarche Karapanou & Papadimitriou, 2010). Freedman et al., 2002 found differences between black and white girls in their pubertal maturation and menarcheal age. In a sample of 2058 girls, the mean age of menarche in black girls was 12.3 years, while 12.6 years in white girls (Freedman, Khan, Serdula, Dietz, Srinivasan & Berenson, 2002). Other factors that affect the pubertal maturation and the onset of menarche are physical activity, body weight, and nutritional status (Karapanou & Papadimitriou, 2010; Freedman, Khan, Serdula, Dietz, Srinivasan & Berenson, 2002). It was found that fat distribution is related to differences in menarche development, with positive correlation between high fat content in hips and buttock and early menarche development in subjects between the age of 10 and 14 years, while high fat content in triceps skinfold was correlated negatively (Lassek & Gaulin, 2007). When the relation between body weight and menarche was measured by (Matkovic et al., 1997), they found that serum leptin
was correlated with increase percent of body fat and body mass index. They also found that there was a correlation between high levels of leptin and early onset of menarche, as for each 1ng/ml increment in serum leptin level was associated with one month earlier of menarcheal age (Matkovic et al., 1997). Leptin is known to stimulate the reproduction in females and helps in pubertal maturation (Chehab, Mounzih, Lu & Lim, 1997). Therefore it associates with earlier menarche (Chehab, Mounzih, Lu & Lim, 1997). Another study that measured the weight factor and menarche was conducted by (Stark, Peckham & Moynihan, 1989). In this study they measured the weight and the menarcheal age of 4427 girls, and found an association between overweight and early menarche age, as 18 percent of the girls who developed their menarche before the age of 11 were overweight, while only three percent who developed their menarche after the age of 14 were overweight. In addition to body weight, nutritional status plays an important role in the menarche onset (Karapanou & Papadimitriou, 2010). Berkey et al., 2000 found that earlier menarche was associated with higher consumption of animal protein and high consumption of fat at an early age (Berkey, Gardner, Frazier & Colditz, 2000).

**Menstrual Cycle Phases**

The follicular phase occurs in the first half of the menstrual cycle (Barbieri, Jaffe & Yen, 1999). This phase is characterized by thickening of the endometrium that increases tenfold than the regular size (Jones, 1991; Levy & Lightman, 1997), and elongation of the uterine glands (Owen, 1975). Also in this phase, some follicles will grow and increase in size while other follicles will not survive (Levy & Lightman, 1997). Ovarian follicle is the functional unit of the ovary; it is composed of oocyte and somatic
cells (granulosa and theca cells) (McGee et al., 1997; Palermo, 2007). Palermo (2007) classified ovarian follicle to primordial follicle that belongs to the resting pool of follicles, and primary follicle which belongs to the growing pool of follicles. As oocyte grows and granulose cell layers increases, parental follicle will develop, followed by antral follicle, and finally griffin follicle in the last stage with a size ranged from 15 to 25 mm in diameter (Palermo, 2007).

**Follicular Phase**

During follicular phase, the follicle undergoes a series of steps (Zeleznik, 2004). Follicular growth starts with a pool of primordial follicles “quiescent” (Findlay, 1994). The primordial follicle will be converted to a parental follicle as a result of granulose cells multiplication (Zeleznik, 2004). When parental follicle increases in size, antral cavity will be formed due to theca internea layer development, and this makes the early antral stage of follicular development (Zeleznik, 2004).

Carr & Blackwell (1993) have described the three major stages of the follicular phase that allows the dominant single follicle to be chosen and developed during this phase. First is the recruitment stage, which occurs in the early follicular phase, day one to four of the cycle. As a result of the increased level of follicular stimulating hormone (FSH) that stimulates follicle recruitment (Zeleznik, 2004), a cohort of follicles are recruited in order to be ovulated or degenerated (Carr & Blackwell, 1993). Next is the selection, the second stage that is characterized by choosing follicle to ovulate from the recruited follicles, which takes place on the day five to seven of the cycle (Carr & Blackwell, 1993; Zeleznik, 2004). Rise of FSH concentration above the FSH threshold
will stimulate the recruited follicles (Messinis, Messini & Dafopoulos, 2010; Palermo, 2007), and causes an increase in growth rate by (1.62 ±0. 05mm/day) (Baerwald, Walker & Pierson, 2009). This leads to opening the “FSH window” which allows the selected antral follicle to enter, because the dominant follicle is the most sensitive to the FSH (Palermo, 2007). After the dominant follicle has been selected, fulliculogenesis occurs at the end of the follicular phase, day eight to 12 of the cycle, which is characterized by growing of the dominant follicle and degenerating the other less mature follicles (Carr & Blackwell, 1993). This stage ends with ovulation (Carr & Blackwell, 1993). The diameter of antral follicle starts with three to five mm and decreases at the end of this phase (Gougeon & Lefèvre, 1983). This diameter decreases by (4.20±0.50 mm) in the mid follicular phase, and by (1.90 ± 0.45mm) by late follicular phase (Carr & Blackwell, 1993). In contrast, the dominant follicle continues to grow and reaches 13mm by the mid follicular phase (Carr & Blackwell, 1993), and will continue to grow until it reaches the pre ovulatory status at the end part of this phase (Baerwald, Adams & Pierson, 2012).

When granulosa cells increased in the dominant follicle, this means having high estrogenic capacity (Baird, 1983). Increasing oestradiol secretion causes FSH to decline below FSH threshold, this will lead to close the “FSH window” and will affect the less mature follicles that depend on FSH for their growth causing them to undergo atrasia (Palermo, 2007; Zeleznik, 2004), while the dominant follicle will proceed to the pre ovulatory stage (Baird, 1983). After decreasing FSH level, granulosa cells in the dominant follicle will develop leuteinizing hormone (LH) receptors in replacement to the FSH receptors, which will help the follicle to be less dependent on the FSH (Zeleznik,
Committed follicle can become ovulatory follicle when the granulosa cells develop LH receptors, after nine to 12 days, and under the process of LH surge ovulation (Jones, 1991; Findlay, 1994). During this phase, there is variation in the action of gonadotropin levels, FSH will rise in the early follicular phase and later will decline, while the LH level will start at a low level and later increases in response to the rise in estrogen level (Carr & Blackwell, 1993). The process of folleculogenesis, or follicular growth, is initiated at the end of the luteal phase of the previous cycle, and ends with the beginning of ovulation (Carr & Blackwell, 1993; Barbieri, Jaffe & Yen, 1999).

**Luteal Phase**

Luteal phase begins with ovulation or follicular collapse, and ends on the first day of next menstrual phase (Owen, 1975; Croxatto, 2008). The main feature of this phase is the rapid growth and development of corpus luteum and increasing level of the progesterone that helps in maintaining the process of pregnancy (Niswender, Juengel, Silva, Rollyson & McIntosh, 2000). Luteal phase lasts about 14 days, with a range of 13 to 15 days, of 70 percent menstrual cycles (Owen, 1975; Carr & Blackwell, 1993; Jones, 1991). Luteal phase is considered to be more constant and straightforward when compared to the follicular phase (Owen, 1975; Carr & Blackwell, 1993; Croxatto, 2008) as most variations that occur during the menstrual cycle is related to variability in follicular phase length (Croxatto, 2008).

The process of ovulation begins with the rapture that occur in the follicular wall, which leads to release the ovum and therefore it will attach to the Fallopian tube (Owen, 1975). Later, the ovum will go to the uterus where it will be degenerated or fertilized
Lutenization will occur for the contracting empty follicle. The rapid growth of the dominant follicle before ovulation stimulates the production of lutenizing hormone which will continue to increase at the time of ovulation and causes “LH surge” that will initiate lutenization (Owen, 1975). The LH surge is initiated when estrogen concentration rise, stimulating the process of granulosa cell lutenization and corpus luteum development (Devoto et al., 2009). This surge lasts for about 48 hours (Barbieri, Jaffe & Yen, 1999), where the ovulation occurs after 34 to 36 hours of the beginning of the surge (Carr & Blackwell, 1993). The follicle starts to have its own vascular supply when the antrum developed, but before that; the primordial and antral follicles depend on the surrounding vessels for blood supply (Hazzard & Stouffer, 2000). However, the granulosa layer doesn’t become vascular until ovulation occurs, and this because the vascular supply before ovulation is located in the basement membrane of the follicle (Hazzard & Stouffer, 2000).

Lutenization of granulose and theca cells happens when there is a rise in the levels of progesterone and 17-α-hydroxyprogesterone in plasma, and this occurred following LH surge (Devoto, Kohen, Muñoz & Strauss, 2009). Therefore, the corpus luteum (CL) can be formed (Stocco, Telleria & Gibori, 2007). Lutenization enhances progesterone synthesis and the large production of progesterone causes the angiogenic activity of granulosa cells to increase in order to form blood capillary vessels (Croxatto, 2008). It is mainly the LH level, which controls the angiogenesis in ovaries (Hazzard & Stouffer, 2000). When CL developed, vascular supply around the follicle increases forming a large network of capillaries (Hazzard & Stouffer, 2000). CL is known to have a high
angeiogenic capacity (Reynolds, Grazul-Bilska & Redmer, 2000). CL is developed after two to three days of ovulation, and its angeinesis activity will reach the highest level (Acosta & Miyamoto, 2004), stimulating the blood flow and CL growth size (Baird, 1992). CL is consists of two types of cells that are important in the synthesis of luteal steroids, those cells are non-steroidegenic cells (immune and fibroblasts), and steroidegenic cells (theca and granulosa cells) (Devoto, Kohen, Muñoz & Strauss, 2009).

CL is also considered to be a non-permanent endocrine gland that is made from the ovulated follicle and produces androgens, oestradiol, as well as progesterone (Devoto, Kohen, Muñoz & Strauss, 2009). Before ovulation, rise in FSH and LH occur as a result of increase in progesterone and estrogen level, however, in the mid-luteal phase a high concentration of progesterone and estradiol will cause negative feedback lead to reduce FSH and LH (Jones, 1991).

In the non-fertile cycle (absence of conception), lutiolysis will occur (Carr & Blackwell, 1993; Devoto, Kohen, Muñoz & Strauss, 2009; Stocco, Telleria & Gibori, 2007), as a result of changing in LH pulse that causes inhibition in progesterone (Devoto, Kohen, Muñoz & Strauss III, 2009). CL will undergo regression and cell death (Stocco, Telleria & Gibori, 2007). On the other hand, the fertile cycle is characterized by rapid CL growth due to HCG production (Devoto, Kohen, Muñoz & Strauss, 2009).

At the late stage of this phase, reduction of progesterone, oestradiol, and inhibin-A will occur in addition to CL regression (Devoto, Kohen, Muñoz & Straus, 2009). Consequently this will cause secretion of pulsatile gonadotropin-releasing hormone
(GnRH) to increase, which will stimulate FSH and lead to recruiting a new early antral
follicle, and a new cycle can be initiated (Stocco, Telleria & Gibori, 2007).

**Menstrual Phase**

The menstrual phase is initiated at the end of the luteal phase when the levels of
progesterone and estrogen decline (Owen, 1975) accompanied with CL degeneration
(Goodman, 2003). At the same time when there is a decline in estrogen and progesterone
due to regression of the CL, ischemic necrosis occurs in endometrial arteries following
prostaglandin secretion, therefore bleeding occurs and menstruation begins (Levy &
Lightman, 1997). Failure of implantation leads to drop in steroids, therefore shedding of
the endometrium, and the first day of bleeding is the sign of the beginning of menstrual
phase (Strassmann, 1996). Endometrium regression, due to low supply of estrogen and
progesterone, causes compression of the spiral arteriols, this leads to vasoconstriction and
low oxygen supply for the vessels (Flowers & Wilborn, 1978). Costricting in blood
vessels that supply the functionalis layer of endometrium causes degeneration of this part
of uterus and result in bleeding (Jones, 1991). Although there is a reduction in the
vascular properties and the height of endometrium, the framework of endometrium
doesn’t change because it needs to be stimulated by FSH and estrogen in order to start a
new reproductive cycle after menstruation finished (Flowers & Wilborn, 1978).

The process of endometrium homeostasis is important in regulating menstrual
bleeding, and it is controlled by many factors: procoagulants, anticoagulants,
antifibrinolytics, and fibrinolytics (Davies & Kadir, 2012). This process undergoes two
main steps, first is the accumulation of platelets at the injured place on endothelial wall
and forming a platelet plug. The second step is forming a clot on the platelet plug, which is done by the fibrin (Davies & Kadir, 2012). At the same time when hormones declined to initiate the menstrual phase, many factors such as macrophages, prostaglandin, cytokines, lysosomes, apoptosis, and matrix metaloproteineasis, needed to be activated so that the vascular breakdown is stimulated (Hickey & Fraser, 2000). The major role of these factors is to produce certain enzymes or molecules that causes tissue destruction and therefore bleeding (Hickey & Fraser, 2000).

Endometrial arteriols are important in providing oxygen and nourishment to the endometrium (Strassmann, 1996; Rogers, 1996). In case implantation occurred, the endometrial arteriols will help with blood supplying and nourishing the placenta. However, if implantation failed, the endometrium will diminish and bleeding will occur (Strassmann, 1996). With each menstrual cycle, functional layer of the endometrium undergoes structural changes, while the basal layer remains the same and doesn’t undergo degeneration (Rogers, 1996). The transient functionalis is located in the superficial layer of endometrium (Strassmann, 1996). The constriction that occurs for the spiral arterioles usually followed by vasodilation and relaxation of these arteries that result in bleeding (Rogers, 1996). After the third day of menstruation, the endometrium will start to develop with the help of rise in estrogen level (Levy & Lightman, 1997). Increase estrogen level causes the epithelial cells of the endometrium to elongate and increase in size, thus it helps in thickening the endometrium (Goodman, 2003). However, progesterone level will remain low until post ovulation (Levy & Lightman, 1997).
From menarche to menopause, the estimated numbers of periods that women experience is about 400 cycles. The expected blood loss per cycle is between 33 to 83 ml (Jones, 1991). Blood loss above 80 ml is considered abnormal and called (HMB) heavy menstrual bleeding (Davies & Kadir, 2012). There are many factors that affect the amount of blood lost each month, such as the number and length of endometrial vessels, endometrial thickness, and the uterus size (Strassmann, 1996). The menstrual blood is characterized by low coaguability that helps to avoid uterine cavity obstruction (Strassmann, 1996). Five days are considered as a mean duration of menstruation phase, while more than seven days is considered abnormal (Davies & Kadir, 2012).

Figure 1. Menstrual cycle phases
Hormonal Changes during Menstrual Cycle

Normal reproductive function and menstrual cycle require organized work between hypothalamus, pituitary gland, and the ovaries (Silberstein & Merriam, 2000), as shown on figure 2 (Popat, Prodanov, Calis & Nelson, 2008). The gonadotropin releasing hormones (GnRH) are produced by the hypothalamus under the influence of many neurotransmitters such as serotonin and norepinephrine (Silberstein & Merriam, 2000). Consequently, the gonadotrophs in the anterior lobe of the pituitary gland will be stimulated to release two glycoproteins that are related to menstrual cycle: luteinizing hormone (LH) and follicular stimulating hormone (FSH) (Levy & Lightman, 1997). Those hormones are secreted in pulsatile mode and are controlled by the central nervous system (Goodman, 2003). This process helps the ovary to produce steroids, estrogen and progesterone, which play an essential role in the menstrual cycle (Silberstein & Merriam, 2000).

The concentration of steroids (progesterone and 17β-estradiol) is responsible to regulate gonadotropins production from the pituitary, and therefore, regulate the menstrual cycle (Baird & Van Look, 1980). Each stage of the menstrual cycle is characterized by different rate of steroid production, for example, progesterone level is (1mg) during early stage of the follicular phase, (4mg) before the ovulation, and increase to reach (25mg) in the middle of luteal phase. On the other hand, Estrogen reaches high levels in the pre-ovulation (350 µg), decrease to (250 µg) in mid-luteal phase, and the lowest rate is during follicular phase (36 µg) (Barbieri, Jaffé & Yen, 199). Some of the conditions, such as PCOS, that causes disturbance in HPO axis regulation, lead to
abnormality in uterine bleeding and causes menorrhagia (Livingstone & Fraser, 2002). Menorrhagia is defined as heavy blood loss from the uterus that exceeds 80 ml (Van Eijekeren, Christiaens, Sixma & Haspels, 1989). Another abnormality that is related to HPO disturbance is Amenorrhea. One of the groups that are exposed to amenorrhea are the anorexic females, and it is a result of very low level of FSH and LH that occurs because of GnRH inhibition (Barbieri, Jaffe & Yen, 1999).

Oral contraceptives contain estrogen, progestin, or both. The main action of the oral contraceptive is to decrease the production of FSH and LH and this leads to inhibit the process of ovulation. The combined oral contraceptive was linked to decrease glucose tolerance, magnesium, zinc, serum folate, B vitamins, albumin, and serum calcium (Carr & Blackwell, 1993).

Figure 2. The reproductive axis in menstrual cycle.
Estrogen

Estrogen is a hormone that plays essential role in the female’s sexual development, breast duct development, endometrium proliferation, prevention of mineral loss in female’s bones and also prevention of atheroschlerosis (Levy & Lightman, 1997). During the menstrual cycle, estrogen plays important role in the preovulatory phase (Ingamells, Campbell, Anthony & Thomas, 1996). In blood, estrogen is circulated binding with sex hormone globin (Goodman, 2003). The synthesis of Estrogen depends on LH and FSH concentration, and the level of progesterone (Goodman, 2003). A balance between estrogen and progesterone level is essential for a normal menstrual cycle (Goodman, 2003). Estrogen helps in preparing the target tissue to react with the progesterone, and It helps in the formation of progesterone receptors therefore stimulating the tissue in response to progesterone (Goodman, 2003). When progesterone level increases in the second part of the follicular phase, a negative effect will occur that leads to inhibit estrogen (Silberstein & Merriam, 2000).

In the follicular phase, as the follicles grow, estrogen level will increase with increasing granulosa cell multiplication, which causes decreased FSH level in mid cycle, therefore the progesterone level will rise with the LH surge (Carr & Blackwell, 1993). In the process of preovulatory follicle development, stimulation of the P450 aromatase enzyme will occur. Granulosa cells, a major ovarian steroidogenic cells, is the place where estrogen will be synthesized under the influence of P450 aromatase (Hillier & Tetsuka, 1997). This enzyme controls the process of androgen formation in thecal cells, androgen is needed to form estrogen (Hillier & Tetsuka, 1997). Another important
enzyme is 13β-HSD which is needed to catalyze the process of converting estradiol to a less active compound that is called estrone, and vice versa. This process is important in maintaining estrogen balance and modulate estrogen levels in different tissues such as ovaries, placenta, and breast (Zhu & Conney, 1998). In the uterus, the activity of 13β-HSD enzyme is at the highest level during the luteal phase of the cycle that occur as a result of increase in progesterone production (Zhu & Conney, 1998). Metabolic degeneration of estrogen occurs in the liver, while the excretion is done by the kidneys (Goodman, 2003). In order for the estrogen to be excreted, it is converted to metabolically inactive compound (Zhu & Conney, 1998) by the hydroxylation and conjugation with sulfate and gluconoride, and then excreted by kidneys (Goodman, 2003).

**Progesterone**

Progesterone plays a major role during the preovulatory stage of the menstrual cycle (Ingamells, Campbell, Anthony & Thomas, 1996). The main site for its production during menstrual cycle is the corpus luteum in ovaries (Gellersen, Fernandes & Brosens, 2009). Progesterone secreted by CL helps the endometrium to accept the fertilized ovum in order to promote pregnancy (Levy & Lightman, 1997). However, it can also be produced by other sites such as placenta and the adrenal gland (Gellersen, Fernandes & Brosens, 2009). The major function of progesterone is to maintain a normal pregnancy (Young & Lessey, 2010), thus a very low level of progesterone is known to be associated with several problems in the reproductive tract such as pregnancy loss, endometriosis, and abnormal bleeding (Gellersen, Fernandes & Brosens, 2009).
The formation of progesterone from cholesterol is considered the initial step in steroidogenesis, and this process is controlled by the rate limiting cytochrome (P450 scc) which depends on cAMP for its expression (Oonk, Krasnow, Beattie & Richards, 1989; Simpson & Waterman, 1988). cAMP helps to increase the level of cholesterol synthesis and facilitate its movement to inner mitochondrial membrane, where there it can be expressed to the cholesterol side chain cleavage cytochrome (Simpson & Waterman, 1988). P450-scc is a side-chain cleavage enzyme that is forming pregnolone, progesterone precursor, by cleaving the cholesterol side chains (Tsutsui, 2008). The next step is converting progesterone to a compound called 17α-hydroxy pregnelone, catalyzed by (P450 17α) enzyme (Simpson & Waterman, 1988). In a later step, 3β-HSD enzyme will convert it to progesterone (Oonk, Krasnow, Beattie & Richards, 1989).

Thecal cells, major ovarian steroidogenic cells, is a site for progesterone and androgen production in the ovaries, where it produces progesterone under the influence of LH (Hillier & Tetsuka, 1997). Although granulosa cells are the place for estrogen production, when it becomes lutenized this will lead to progesterone synthesis in the corpus luteum (Hillier & Tetsuka, 1997). The synthesis of progesterone in thecal cells is regulated by LH, while in granulosa cells by FSH (Oonk, Krasnow, Beattie & Richards, 1989).

During the follicular phase, estrogen helps to stimulate the development of progesterone receptors in endometrium, which will help to increase progesterone level, and consequently, estrogen will decrease (Young & Lessey, 2010). Progesteron reduces the level of estrogen by stimulating the enzyme 17β hydroxyl steroid dehydrogenase
(17β-HSD) which catalyzes the formation of inactive estrones from the estradiols, this will decrease estrogen concentration (Bulun et al., 2002). In addition, progesterone can decrease the regulation of estrogen receptors in endometrium, which will reduce the response to estrogen by endometrium (Young & Lessey, 2010). A balance between both hormones is required for normal menstrual cycles and normal reproduction (Young & Lessey, 2010).

**Follicle Stimulating Hormone (FSH)**

The follicle stimulating hormone is a glycoprotein synthesized by the pituitary gland and stimulated by gonadotropin releasing hormone (GnRH) which is responsible for controlling FSH production (Palermo, 2007). FSH has mean half-life of 149 minutes, and it can be cleared from the blood by the liver (Palermo, 2007). The major function of FSH is to initiate the process of follicular recruitment and development during the follicular phase of the menstrual cycle (Levy & Lightman, 1997). In addition, it helps in synthesizing oestradiols (Levy & Lightman, 1997). FSH is composed of α-subunit and β-subunit (Palermo, 2007). All glycoproteins - FSH, LH, gonadotropins, and thyroid stimulating hormone- have similar α-chain but they differ in their β-chain which specifies the function of each hormone (Fan & Hendrickson, 2005). Besides GnRH, FH is also controlled by inhibin and activin (Gregory & Kaiser, 2004), both with follastin are able to regulate the production and secretion of FSH and also LH from the gonadotropin cells that are located in the anterior pituitary gland (Gregory & Kaiser, 2004). Inhibin is produced from the ovary and its main function is to inhibit FSH production (Gregory & Kaiser, 2004), which occur before the process of follicular selection (Baerwald, Adams &
Pierson, 2012). Activin is produced from many tissues in the body such as granulosa cells and anterior pituitary gland, it helps in granulose cells development in follicles and stimulates FSH production (Baerwald, Adams & Pierson, 2012).

Gonadal hormones can have different mechanisms in FSH regulation, they can work on the gonadotrope cells, or gonadotropin releasing hormone receptors in order to stimulate the hormone. Gonadal hormones can also affect the hypothalamus neuron that controls the secretion of gonadotropin hormones (Gregory & Kaiser, 2004). Gonadotropin hormones can function through receptors called G-protein coupled receptors (GPCRs) (Fan & Hendrickson, 2005). LH acts through LH receptors (LHR) that are stimulated under the FSH action, in order to help the developing follicles to react with the LH in a later stage of the follicular phase (Sullivan, Stewart-Akers, Krasnow, Berga & Zeleznik, 1999). FSH acts through FSH receptors (FSHR) that are located in the granulose cells, and it was found that the different FSHR genotypes between women result in variation in FSH secretion levels in normal menstrual cycle (Mayorga, Gromoll, Behre, Gassner, Nieschlag & Simoni, 2000).

FSH has an essential role in stimulating the enzyme aromatase (Mayorga, Gromoll, Behre, Gassner, Nieschlag & Simoni, 2000). In the final stage of the follicular growth, (P450 aroma) is stimulated, which leads to estrogen synthesis in granulosa cells from the androgen that is located in theca cells (Tetsuka & Hillier, 1997). Estrogen will stimulate the follicular sensitivity to FSH as it is required for the growth and development of the follicles (Owen, 1975).
The “FSH window” concept is defined as the time when FSH concentration increases, and maintains this concentration at a level above the FSH threshold, which is required to determine the process of dominant follicle selection (Baerwald, Adams & Pierson, 2012). The FSH threshold mechanism is controlling the concentration of FSH in the blood, as when FSH reaches high concentration, then several reactions will occur in order to decrease the level below threshold (Sullivan, Stewart-Akers, Krasnow, Berga & Zeleznik, 1999). Decline FSH helps the dominant follicle to grow alone, while the less mature follicles will not be able to survive under the low FSH concentration and they will undergo atresia (Sullivan, Stewart-Akers, Krasnow, Berga & Zeleznik, 1999).

**Luteinizing Hormone (LH)**

The Lutenizing hormone, or lutropin, is a glycoprotein that is synthesized by the pituitary gland under the control of gonadotropin releasing hormone (GnRH) (Palermo, 2007). LH contains two subunits α-subunit and β-subunit (Palermo, 2007; Shoham, 2002). Each subunit contains different number of amino acids and different molecular weight (Shoham, 2002). Beta subunit is what differentiates the LH from the other glycoproteins and gives it its unique function (Shoham, 2002).

The process of LH production is affected by negative and positive feedback mechanisms (Shoham, 2002). The production is stimulated under the rise of estrogen level, while inhibiting under the rise of progesterone that causes negative feedback (Shoham, 2002). When LH is synthesized, it is not easy to measure it in the plasma until the LH surge occurs (Owen, 1975). The main reason for the LH surge occurrence is to stimulate the process of ovulation (Levy & Lightman, 1997). LH has a shorter half-life
when compared to FSH (Shoham, 2002). With a mean half-life of 30 minutes (Palermo, 2007). In addition, the process of LH excretion through the liver and kidney is faster than FSH, because it contains lower amounts of sialic acid residues (Shoham, 2002). The highest level that LH can reach is 10 to 16 hours before ovulation (Silberstein & Merriam, 2000).

The major function of LH is helping the follicular development and steroidogenesis by stimulating cAMP synthesis (Shoham, 2002). At the beginning of the follicular phase, LH receptors are located on the thecal cells of the follicle (Goodman, 2003; Caglar, Asimakopoulos, Nikolettos, Diedrich & Al-Hasani, 2005). The main role of LH at this stage is to stimulate androgen production, which will convert later to estrogen under the influence of FSH (Caglar, Asimakopoulos, Nikolettos, Diedrich & Al-Hasani, 2005). During the late stage of follicular phase, LHR will also be located on granulosa cells, helping the selected follicle to grow and survive under a low concentration of FSH (Caglar, Asimakopoulos, Nikolettos, Diedrich & Al-Hasani, 2005). The mature follicle becomes less dependent on FSH and more rely on LH as they have the LHR, however, only one percent of these receptors are needed for the follicle growth (Palermo, 2007).

During the luteal phase, the main function of LH is to stimulate progesterone production (Levi-Setti, Cavagna, Baggiani, Zannoni, Colombo & Liprandi, 2004). Luteal phase is initiated when LH concentration goes beyond the “LH ceiling” which ends the granulosa cells multiplication (Palermo, 2007). High LH concentration will stimulate the ovulation of mature follicles, helps in the formation of the corpus luteum, and stimulates
the production of steroids by CL (Goodman, 2003). LH is critical for CL formation, but with a minimal amount (Owen, 1975). Although LH is important in follicular development, high level can cause post-mature oocyte that undergoes ovulation, and it also contributes to miscarriage (Levi-Setti, Cavagna, Baggiani, Zannoni, Colombo & Liprandi, 2004) and related to polycystic ovarian syndrome (Shoham, 2002).

The secretion of FSH and LH during the menstrual cycle is interval related (Caglar, Asimakopoulos, Nikolettos, Diedrich & Al-Hasani, 2005). In the beginning of the follicular phase, FSH level is high which causes a decline in LH, this helps in follicular growth. In mid follicular phase, FSH will stimulate estrogen production, which then will lead to inhibit FSH and causes LH surge to occur (Caglar, Asimakopoulos, Nikolettos, Diedrich & Al-Hasani, 2005).

**Polycystic Ovarian Syndrome**

Polycystic ovarian syndrome is an endocrine disorder that is characterized by anovulation and hyperandrogenism which are not related to pituitary or adrenal gland disorders (Franks, 1995). Elevated level of androgen, acne, alopecia, and hirsutism are signs that are related to hyperandrogenism (Franks, 1995). Women with PCOS have high number of large follicles in their ovaries – more than 12- and each one is range from two to nine mm in diameter (Hart, Hickey & Franks, 2004). Many signs and symptoms are related to PCOS and in different degrees such as oligomenorrhea, amenorrhea, obesity, hirsutism, acne, and infertility (Hart, Hickey & Franks, 2004). Ultrasonographic method is mainly used in PCOS diagnosis, in addition, clinical and biochemical assessments should be taken into account (Franks, 1995). When pelvic ultrasound was taken to 173
women who were complaining of either amenorrhea (n=73), oligomenorrhea (n=75), or idiopathic hirsutism (n=25), it was found that 92 percent of women with hirsutism, 87 percent of women with oligomenorrhea, and 26 percent of women with amenorrhea were diagnosed with PCOS (Adams, Polson & Franks, 1986).

Endocrine disturbance that occurs in PCOS is characterized by elevated level of LH, high concentration of androgens (testosterone and androsterone), disturbance in estrogen production, high prolactin level, and low growth hormone production (Franks, 1995). One of the major risk factors that is associated with PCOS is insulin resistance. Insulin has the ability to decrease the secretion of sex hormone binding globin and insulin like growth factor binding protein. This result in rise in testosterone and androgen production (Norman, Hickey, Moran, Boyle, Wang & Davies, 2004). Obesity has been found to be associated with PCOS especially because it relates to many risk factors such as high level of insulin resistance (Norman, Hickey, Moran, Boyle, Wang & Davies, 2004). Many treatment methods are suggested such as weight loss to treat obesity, oral antihyperglycemic medication to sensitize insulin (Wei & Pritts, 2003). Some therapies to stimulate ovulation are used such as clomiphine citrate or gonadotropins injection. Surgical procedures can be used in order to reduce thecal layer of the follicle, thus help in decreasing androgen production. In addition, oral contraceptives are used to reduce LH and androgen levels (Wei & Pritts, 2003).

**Endometriosis**

Endometriosis is characterized by the endometrium-like glandular tissue and stroma are located outside the uterus (Vinatier, Orazi, Cosson & Dufour, 2001). The
prevalence of endometriosis is about five to 15 percent in women, and it affects 60 to 80 percent of infertile women or who complain of pelvic pain (Vinatier, Orazi, Cosson & Dufour, 2001). Endometriosis is related to early menarcheal age and heavy menstrual bleeding (Viganò, Parazzini, Somigliana & Vercellini, 2004). Endometriosis is known to be a risk factor for infertility and dysmenorrhea (Darrow, Vena, Batt, Zielezny, Michalek & Selman, 1993). It was found that irregular menstrual cycle in women less than 30 years old was associated with increase the risk of developing endometriosis by 50 percent. The signs of irregular cycle were more than six days menstruation, with heavy bleeding and severe cramps (Darrow, Vena, Batt, Zielezny, Michalek & Selman, 1993).

Apoptosis is an important physiological process that helps to maintain cellular homeostasis by programmed cell death. This process is essential during the menstrual cycle in order to maintain homeostasis in healthy women, however, in endometriosis patient the apoptosis of endometrial cells is affected and reduced (Viganò, Parazzini, Somigliana & Vercellini, 2004). The main tools that are used to diagnose endometriosis are laposcopy, magnetic resonance imaging (MRI), in addition to physical and clinical assessment such as history of pelvic pain and dysmenorrhea (Teirney & Prentice, 2002). A major goal of endometriosis treatment is to reduce the ovarian steroid hormone secretion, therefore inhibit endometrium growth. Some treatment methods are using oral contraceptive pills, progesterone, danazol, or gonadotropin releasing hormone analogues (Teirney & Prentice, 2002).
Factors Affecting Menstrual Cycle

Normal body weight is essential to maintain normal reproduction, as very low or very high body weight is associated with menstrual disturbance and failure to maintain reproductive function (Pasquali, Patton & Gambineri, 2007). In addition, obesity is known to be associated with high leptin level, high insulin, and changing in reproductive hormone profile. One of the tissues that aromatase activity takes place on is the adipose tissue, and mainly this enzyme will be affected by central obesity that causes androgen accumulation (Pasquali, Patton & Gambineri, 2007).

Physiological Factors

Obese infertile women are having significantly higher level of androgen and testosterone (Bates & Whitworth, 1982). Central obesity is also related rise the insulin levels that affects androgen production from the ovaries, and raise the level of insulin like growth factor (IGF-1) that increases the androgens. In addition, they tend to have an irregularity in gonadotropin secretion presented by low level of LH (Pasquali, 2006). Sex hormone-binding globin (SHBG) is an important carrier for androgens and estrogens (Pasquali, Pelusi, Genghini, Cacciari & Gambineri, 2003). In obese women, especially central obesity- a high level of insulin causes suppressed SHBG production from the liver, this causes the testosterone to accumulate as it requires the SHBG for its clearance. In addition, estrogen level increases with declining SHBG, however, estrogen level tend to be higher in peripheral obesity than in central obesity (Pasquali, Pelusi, Genghini, Cacciari & Gambineri, 2003). The data of a case control study showed a relationship between obesity and menstrual cycle disturbance (Castillo-Martínez, López-Alvarenga,
Villa & González-Barranco, 2003). In 120 women who were obese, 18.3 percent of them had oligimenorrhea, 11.4 percent had amenorrhea, and 30 percent complained of irregular menstruation. 45 percent of the dysmenorrheic women were in grade four or five of obesity. In this study, it was found that as obesity grade increased, consequently the risk of oligomenorrhea and amenorrhea increased (Castillo-Martínez, López-Alvarenga, Villa & González-Barranco, 2003). In a study where the menstrual cycle of 3941 women was measured, it was found that there was a correlation between body mass index (BMI) and menstrual cycle regularity and length. As BMI increases, the menstrual cycle irregularity and length increases (Rowland, Baird, Long, Wegienka, Harlow, Alavanja, Sandler, 2002). Increased body fat is related to many reproductive problems such as irregular menstruation, miscarriage, and anovulation (Pasquali, Pelusi, Genghini, Cacciari & Gambineri, 2003).

**Environmental Factors**

There are many internal and external factors that affect the Hypothalamic-pituitary-ovarian axis, therefore causing changes in steroid hormones and these changes affect the length of menstrual cycle, duration of bleeding, and variation in menstrual pattern (Cooper, Sandler, Whelan & Smith, 1996).

**Alcohol.** Alcohol drinking is known to cause changes in the menstrual cycle (Liu, Gold, Lasley & Johnson, 2004). Drinking more than one alcoholic drink per week was associated to decrease the duration of the follicular phase, thus decreasing the menstrual length (Liu, Gold, Lasley & Johnson, 2004). In a study where 80 women were measured to determine the effect of alcohol on menstrual cycle, it was found that
drinking was related to menstrual cycle and reproductive hormone disturbance among 60 percent of heavy drinkers (more than 5 drinks/day), and 50 percent of social drinkers (2.5 to 5 drinks/day). In addition, high prolactin level was seen in three on the heavy drinkers and one social drinker, and anovulatory cycles were found in three social drinkers (Mendelson & Mello, 1988). Shorter menstrual cycle was found in women with alcohol abuse (Barron, Flick, Cook, Homan & Campbell, 2008).

**Caffeine.** It was hypothesized that caffeine can cause changes in hormone profile in women therefore change menstrual cycle pattern (Fenster et al., 1999). The caffeine intake from coffee, tea and soda was measured in 403 women, and they were divided into four groups according to the amount of caffeine consumed: none, low intake (1 to 150 mg/d), moderate (151 to 300 mg/d), and high (>300 mg/d). The results showed that heavy caffeine intake was associated decrease menstrual cycle length compared with the other groups especially the low intake. The proposed mechanism was the vasoconstriction ability of caffeine that reduces blood flow in the uterus and also the ability for caffeine to alter sex hormones (Fenster et al., 1999).

**Smoking.** Cigarette smoking is associated with irregular and short menstrual cycles (Rowland, Baird, Long, Wegenka, Harlow, Alavanja, Sandler, 2002). Windham et al., 1999) measured the steroid hormones for 408 women to determine the pattern of seven menstrual cycles, also the smoking level was measured by dividing the subjects into three groups: nonsmokers, low smokers (<20 cigarettes/day) and heavy smokers (>20 cigarettes/day). The result showed that the menstrual cycles of heavy smokers were irregular and shorter (less than 25 days for one cycle). 20.5 percent of the women who
were experiencing short cycles were heavy smokers, 14.5 percent were low smokers, while only 8.7 percent were nonsmokers (Windham, Elkin, Swan, Waller & Fenster, 1999).

**Physical activity.** Different types of sports have an effect of female’s reproductive function and menstrual cycle pattern, whether these sports are weight bearing activities such as ballet, or non-weight bearing such as swimming. Delayed menarcheal age, amenorrhea, and irregular menstruation are some of the complications that are caused by hormonal disturbance as a result of intense exercise pattern (Warren, Perlroth, 2001).

Participating in sports that require a low body weight such as ballet, causes disturbance in hormonal profile. Very low body weight affects the hypothalamic-pituitary-ovarian axis, therefore the production of GnRH, LH, and FSH will be suppressed, causing delay in menarche (Warren & Perlroth, 2001). Studies who examined the effect of physical activity on female growth found that females who participate in strenuous sports such as gymnastics tend to have lower body fat content, height and weight, comparing with those who are engaged in less strenuous activities (Rogol, Clark & Roemmich, 2000). Brooks-Gunn et al., 1987 measured the menstrual pattern in 55 ballet dancers. They found that 56 percent of the dancers had significantly delayed menarche (M= 14.29 years, P <0.0). Menstrual irregularity such as oligomenorrhea was present of 40 percent of the dancers, and amenorrhea was present in 19 percent of the dancers and was significantly related to very low body weight (Brooks-Gunn, Warren & Hamilton, 1987).
Strenuous exercise is associated with menstrual cycle disturbance, as it causes suppression in hypothalamic function which leads to decrease LH, FSH, and estradiol production (Mitan, 2004). Many factors determine the severity of reproductive dysfunction and menstrual disturbance such as type of exercise, percent of body fat, body weight, dietary restriction, and the presence of eating disorder such as anorexia nervosa (Warren, Perlroth, 2001). Theintz et al., 1993 assessed the effect of physical activity on pubertal development of 22 highly trained female gymnasts and 21 moderately trained swimmers, at the age of 12. By following the groups, it was found that the subjects in the swimming group developed their menarche earlier (12.9 ±0.9 years) than the gymnasts group (14.5 ±1.2 years). Similar to this result (Georgopoulos et al., 1999) found a delay in menarche age in 32 percent of 22 female gymnasts (14.3 ±1.46) when that result compared to the menarche age of their mothers and sisters, in addition, a positive correlation was found between training intensity and delayed menarche age (P < 0.001) (Theintz, Howald, Weiss & Sizonenko, 1993).

**Oral Contraceptives.** Oral contraceptives (OC) are prevalent among women for birth control (Spitzer, Lewis Heinemann & Thorogood, 1996). Some studies, they found using low doses of OC helpful in maintaining one mass and preventing osteoporosis (Kuohung, Borgatta & Stubblefield, 2000). Another finding that the body composition and BMI for the OC users did not differ from the non-OC users (Lloyd, Lin, Matthews, Bentley & Legro, 2002). When food craving and negative mood examined between OC users and non-OC users, both groups were similar in their craving, however, the OC group experienced low levels of negative mood (Bancroft & Rennie, 1993). Some women
may experience headache, change in weight and nausea when using OC, and it was found to be associated with an increase in cholesterol level (Lloyd, Lin, Matthews, Bentley & Legro, 2002).

**Psychological Factors**

During the menstrual cycle, many psychological changes can occur and causes fluctuations in different phases of the cycle (Herrera, Gómez-Amor, Martínez-Selva & Ato, 1990).

**Stress.** Severe stress is known to be associated with amenorrhea and irregular menstruation (Young, Midgley, Carlson & Brown, 2000) the main proposed mechanism is that stress stimulates the hypothalamus-pituitary-adrenal axis (HPA) activity in this causes inhibition in the activity of hypothalamic-pituitary-ovarian axis (HPO). In addition, it causes disturbance in the reproductive hormones especially lowering the LH production (Young, Midgley, Carlson & Brown, 2000). Collins, Eneroth & Landgren, 1985 stress was related to FSH and estradiol fluctuation throughout the menstrual cycle. Barsom, Mansfield, Koch, Gierach & West, 2004 found no association between stress level and menstrual cycle (length or bleeding), however, decreasing the stress was related to increase menstrual phase length. Work stress was measured by (Fenster, Waller, Chen, Hubbard, Windham, Elkin & Swan, 1999) and found its relation to decrease menstrual cycle length ($\leq 24$ days) especially reducing the duration of the follicular phase in women aged from 18 to 39 years.
**Depression.** On the other hand, depression was associated with long and irregular menstrual cycles (Rowland, Baird, Long, Wegienka, Harlow, Alavanja, Sandler, 2002). Angst, Sellaro, Stolar, Merikangas & Endicott, 2001 measured several psychologic symptoms and its relation to the timing of menstruation. They found association between the occurrence of depressed mood and the irregularity of menstrual phase when compared with other symptoms such as anxiety, tension, and nervousness. It was also found that the prevalence of these symptoms was the highest during premenstrual phase (Angst, Sellaro, Stolar, Merikangas & Endicott, 2001). Chau, Chang & Chang, 1998 measured different scales of anxiety, craving water retention, and depression in relation to premenstrual tension. It was found that the anxiety scale (tension, mood swing, irritability) had the highest effect on premenstrual tension. One of the psychiatric disorders that was studied in relation to the menstrual cycle is bipolar disorder (BPD) (Rasgon et al., 2005).

Irregular menstrual cycle was found in 65 percent of 80 women complaining of BPD, also change in cycle frequency and blood flow was observed (Rasgon et al., 2005). In addition, many psychiatric medications such as psychotropic medication causes irregular menstruation due to their effect in changing reproductive hormone level (Rasgon et al., 2005).

**Eating disorders.** Eating disorders such as anorexia nervosa (AN) and bulimia nervosa (BN) are related to menstrual cycle irregularity (Casanueva, Borras, Burguera, Muruais, Fernandez & Devesa, 1987; Devlin, 1989).

Anorexia nervosa (AN) is a health condition where the patient fails to maintain normal body weight, with a decrease of more than 25 percent of regular weight that is
caused by psychological problems mainly the concern of being obese (Casanueva, Borras, Burguera, Muruais, Fernandez & Devesa, 1987). AN is one of the main risk factors of amenorrhea (absence of menses) (Mitan, 2004). It is characterized by disturbance in reproductive hormones. Estrogen, LH and FSH are low which causes absence or irregular menstruation depending on the severity and the amount of weight loss (Mitan, 2004; Casanueva, Borras, Burguera, Muruais, Fernandez & Devesa, 1987). In addition, low levels of leptin and insulin like growth factor are seen in anorexic female who developed amenorrhea (Mitan, 2004). Surbey, 1987 believed that amenorrhea is a normal response by the body for the stress and starvation. Amenorrhea in considered to be main diagnostic criteria for anorexic patient (Devlin, 1989). It was suggested that diminish GnRH is an important cause for menstrual cycle cessation in anorexic women (Devlin, 1989).

Another eating disorder is bulimia which is characterized by frequent episodes of binging followed by purging or a very low diet intake. Bulimia patients usually have regular weight, in addition to some of AN characteristics such as amenorrhea or oligomenorrhea. HPA axis dysfunction was seen in AN and BN subjects. Fichter, Pirke, Pöllinger, Wolfram, G., & Brunner, 1990 found that a high number of fasting days and increase in dietary restriction are related to reduction in FSH and LH (Devlin, 1989).
**Dietary Changes during Menstrual Cycle**

There are many factors that affect energy expenditure, and one of these factors is menstrual cycle (Howe, Rumpler & Seale, 1993). Hormonal changes during different phase causes change in metabolism, with high level of progesterone during luteal phase linked to increase metabolic energy expenditure (Howe, Rumpler & Seale, 1993).

**Metabolism**

The luteal phase is characterized by having high resting metabolic rate (RMR) by 18.4 percent higher than the follicular phase. In this study, high RMR was not related to significant increase in energy and macronutrient intake during the luteal phase (Piers, Diggavi, Rijkamp, Van Raaij, Shetty & Hautvast, 1995). Bisdee, James & Shaw, 1989 found an increase in energy expenditure during the luteal phase especially in the last stage of this phase. In addition, (Tai, Castillo & Pi-Sunyer, 1997) found that the last stage of luteal phase was characterized by high thermic effect of food (TEF), however, TEF was low at an early stage of this phase. Webb, 1986 found that in the 14th day of the menstrual cycle –during luteal phase- energy expenditure increases by 8 to 16 percent after the process of ovulation. Webb, 1986 suggests that 9 percent of this increase in EE was due to increase progesterone level as it is responsible to stimulate the metabolic rate. Solomon, Kurzer & Calloway, 1982 measured basal metabolic rate (BMR) throughout the menstrual cycle, found that the menstrual phase had a low level of BMR while the lowest level was before one week of ovulation.
Dietary Intake

Fluctuation in both hormones, estrogen and progesterone, was linked to changes in food intake in different phases of the menstrual cycle. Increase in food intake during luteal phase is related to elevated progesterone levels, while low appetite and decreased food intake during the follicular phase was linked to high estrogen levels (Dalvit-McPhillips, 1983; Johnson, Corrigan, Lemmon, Bergeron & Crusco, 1994; Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988). Many studies have measured the changes in macronutrient intake (carbohydrate, fat, and protein) and total energy intake during throughout the menstrual cycle (Tarasuk & Beaton, 1991; Lyons, Truswell, Mira, Vizzard & Abraham, 1989; Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988; Gong, Garrel & Calloway, 1989).

(Lissner et al., 1988) found that the mean energy intake during luteal phase – 10 days before menstruation- (2335 kcal) was significantly higher (p<0.006) by 87 kcal when compared to post menstrual phase. High progesterone level was linked to increase the appetite in this study (Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988). Another study found a high caloric intake during the luteal phase (M=214 kcal) higher than follicular phase. However, this study found no significant difference between luteal and menstrual phase in total energy consumption (Gong, Garrel & Calloway, 1989). Hill & Heaton-Brown, 1994 have found a 500 kcal difference between premenstrual and post menstrual phases, with higher calories during the premenstrual phase. Dalvit-McPhillips, 1983 measured the intake of carbohydrate, protein and fat in the period before and after ovulation. The results showed a stable intake of both protein and fat throughout the cycle,
while carbohydrate was fluctuated. Carbohydrate intake was higher by about 54 percent before menstrual cycle (Dalvit-McPhillips, 1983). In addition, (Johnson et al., 1994) found a significant difference in fat intake between follicular and luteal phase, with higher amounts (9.2 g) of fat during the luteal phase, while protein intake was stable in both phases (Johnson, Corrigan, Lemmon, Bergeron & Crusco, 1994). Similar to this finding, (Tarasuk & Beaton, 1991) resulted in a significant increase of fat consumption during the luteal phase, but there wasn’t differences in protein and carbohydrates. By measuring the macro and micronutrients intake, (Martini, Lampe, Slavin & Kurzer, 1994) have found significant increases in all micronutrients and energy intake during the luteal phase. Although there was a higher intake of vitamin D, phosphorus, and magnesium during the luteal phase, but it wasn’t significant (Martini, Lampe, Slavin & Kurzer, 1994).

One of the disorders that affects food intake during the menstrual cycle is premenstrual syndrome (PMS) (Wurtman, Brzezinski, Wurtman & Laferre, 1989). PMS women had significantly higher rates of depression, carbohydrate intake, and appetite during the last stage of luteal phase (p < 0.0001). During this stage, caloric consumption increased by 274 kcal, and carbohydrate intake was higher by 24 percent, while protein intake did not change. Carving for carbohydrates in PMS subjects was linked to decrease depression and negative emotions (Wurtman, Brzezinski, Wurtman & Laferre, 1989). Each phase of the menstrual cycle is characterized by different energy and macronutrient intake. Luteal phase is considered to have higher intake when compared with the rest of the menstrual cycle (Barr, Janelle & Prior, 1995).
**Appetite and Menstrual Cycle**

Appetite has objective and subjective characteristics that control the amount and type of food consumed (Dye & Blundell, 1997). Some of the objective characteristics are sensory reactions such as taste and smell, combined with amount of food. While the subjective characteristics such as feelings of hunger and fullness that initiate the beginning and ending of the eating process (Dye & Blundell, 1997). There are many factors that contribute to increase and decrease the appetite in females (Hill & Heaton-Brown, 1994). One of the main factors is hormonal fluctuation during different phases of the menstrual cycle. Hormone fluctuation affects food intake therefore eating pattern (amount, type, timing) of food consumed (Dye & Blundell, 1997). The two main hormones that have an effect on regulating appetite, whether this effect was direct or indirect, are estrogen and progesterone (Buffenstein, Poppitt, McDevitt & Prentice, 1995). Many mechanisms that occur in the body parallel to ovarian hormone vary during the menstrual cycle such as gluconeogenesis and lipid metabolism, these mechanisms have an effect on signaling the appetite and affecting food intake. Estrogen has its effect in the process of lipolysis which results in increase free fatty acids and decrease the appetite (Buffenstein, Poppitt, McDevitt & Prentice, 1995).

In addition, estrogen has an effect in regulating many neurotransmitters such as serotonin, dopamine, and noradrenalin (Buffenstein, Poppitt, McDevitt & Prentice, 1995). Brain serotonin (5-HT) concentration is known to be related to food intake and appetite regulation. It was found that high concentration of serotonin was linked to suppression the preference to carbohydrate- rich food m while slightly enhance the
preference of fat and proteins (Leibowitz, Weiss, Walsh & Viswanath, 1989). The effect of serotonin on macronutrient intake was higher in carbohydrate comparing with the other macronutrients (Leibowitz, Weiss & Suh, 1990). It was found that decreasing carbohydrate was associated with high level of serotonin, while the protein and fat consumption wasn’t affected (Leibowitz, Weiss & Suh, 1990). Carbohydrate was related to stimulate serotonin precursor (tryptophan). Carving the CHO might be a reaction to the low level of serotonin (Buffenstein, Poppitt, McDevitt & Prentice, 1995). In addition, the conversion of domapmin to noradrenalin is catalyzed by (dopamine beta-hydroxylase). Estrogen is able to inhibit this enzyme, leading to decrease appetite as a result of low level of noradrenalin (Buffenstein, Poppitt, McDevitt & Prentice, 1995).

**Food Craving**

Craving is generally defined as “an increase desire to a particular substance” (Weingarten & Elston, 1990). In many situations “craving” was linked to “addiction” (West, 1987). Although craving was always defined as a strong desire or urge, this may result later to cause addiction, in order to fulfill this particular need for the craved substance. However, (West, 1987) argued that in order to give the word craving this definition is not clear or precise, because the level of “feeling a strong desire” might differ in strength and intensity from one person to another. When compared to addiction, (Kozlowski & Wilkinson, 1987) considered craving to be more subjective. Kozlowski & Wilkinson, 1987 argued that the researchers who were the term “craving” in explaining a desire for substance like alcohol, this term is nor specific and he suggested that this term should explain an action that is characterized by sudden, not expected, and strong
reaction, and this action could be socially unacceptable. There are many proposed ways to measure cravings, such as self-report of craving episode on a scale from one to ten. Another way is to measure the amount of the craved substance, whether it was specific nutrient, alcohol, or drug. Also, measuring the speed of consumption of the substance. In addition, psychological indicators such as measuring heart rate can be used (Weingarten & Elston, 1990).

**Types of cravings.** One of the types of craving is food craving. Food craving was studied in many research and was linked to many conditions such as menstrual cycle, PMS, bulimia nervosa, and compulsive eating disorder. Some of the most craved food is chocolates and carbohydrate rich food (Kozlowski & Wilkinson, 1987). Another type is pica. Craving for non-food or non-nutritious items is the definition of pica that is seen mainly in pregnant women or in individuals who are complaining of nutritional deficiencies such as iron deficiency anemia (Rose, Porcherelli & Neale, 2000). Many substances are consumed by pica patients such as ice, ashes, clay, and chalks (Rose, Porcherelli & Neale, 2000).

Another type of craving is alcohol. High level of alcohol craving was associated with high level of obsession among alcoholic subjects (Modell, Glaser, Cyr & Mountz, 1992). Craving for cigarette smoking is another type of craving. There are many variables that are used to determine craving for cigarettes such as: having a desire or urge to smoke, wanting cigarettes immediately when thinking of it, also measuring whether it is associated with a decrease in negative emotions (Kozlowski, Pillitteri, Sweeney, Whitfield & Graham, 1996). Another type is drug craving. Measuring the episodes and
the level of drug craving was used to determine the process of drug withdrawal and relapse (Kozlowski & Wilkinson, 1987).

**Causes of food craving.** The phenomenon of food craving was linked to many physiological and psychological conditions, such as pregnancy, depression, and eating disorders (Weingarten & Elston, 1990). It is also linked to the hormonal and psychological changes during menstrual cycle (Cohen, Sherwin, Fleming, 1987). Pelchat suggested that the process of food craving is not a result of increase appetite or hunger and the episodes of food craving are not usually occur on a daily basis by consuming regular food (Pelchat, 2002). When the feeling of hunger is results from psychological demand for food due to low calorie intake, craving for certain food is mainly results from psychological purpose to relief intense desire for that food in addition to stress or tension (Rabinovitz, 2005).

Eating disorders are characterized by many factors that predispose to food craving such as mood change, anxiety dietary restriction, and a low serotonin level (Gendall, Sullivan, Joyce & Bulik, 1997). In some bulimic subjects, food craving is considered as a beginning of binge episode. It was found that food craving when accompanied with binging leads to increase negative emotions and feeling the tension, while food craving alone was associated with decrease the negative emotions (Waters, Hill & Waller, 2001). The process of “emotional eating” was linked to psychological factors. A high level of anxiety and negative mood were linked to increased food craving, however, in this study they found no significant relation between dieting and food craving (Hill, Weaver & Blundell, 1991).
The types of food are an important component of the craving experience, as carbohydrate rich food considered more craved than savory food (Tiggemann & Kemps, 2005). Serotonin level was linked to food craving especially carbohydrates (Pelchat, 2002). Carbohydrate is known to stimulate the process of serotonin synthesis from tryptophan. A low serotonin level causes increases the appetite to carbohydrate containing food (Pelchat, 2002). When correlation between sensory modalities and imagining the craved food was measured, it was found that the visual effects of food had the highest score in stimulating the craving process compared to gesture, olfactory, tactile, and auditory factors (Tiggemann & Kemps, 2005).

Other factors related to food craving are age and gender (Pelchat, 1997). Women tend to crave more chocolate than men. When 128 subjects were measured, there was 42 percent of women craved chocolate compared with only 11 percent of men (Tiggemann & Kemps, 2005). found that young adults significantly had a higher craving level than older adults. In addition, female were more than males in their craving episodes especially for chocolates (Pelchat, 1997) Another cause for food craving is dietary restriction, people who follow a restricted diet tend to have more craving episodes (Pelchat, 1997). Alcohol relapse, tobacco cessation, and drug withdrawal are among the factors that are related to craving (Kozlowski & Wilkinson, 1987).

**Food craving during menstrual cycle.** Many studies have linked the episodes of food craving during the menstrual cycle with psychological conditions such as depression, PMS, and PMDD (Dye, Warner & Bancroft, 1995; Yen, Chang, Ko, Yen, Chen, Yeh & Chen, 2010; Smith & Sauder, 1969). (Dye, Warner & Bancroft, 1995)
found a relationship between food craving and menstrual cycle, where 74.3 percent of the tested subjects (n=5549) reported that they experienced food craving. In addition, high level of food craving was associated with a high degree of depression in all phases of the cycle. By measuring 284 nurses, (Smith & Sauder, 1969) found that 66 percent of these nurses were experiencing signs of depression before menstrual phase. Also they found a significant relationship between sweets craving, PMS, and depression (p< 0.001). PMS was lower in 30 percent of the subjects who craved spicy food.

When the premenstrual –luteal phase was compared to the menstrual and follicular phases, it was found that it had the highest percentage of occurrence of food craving episodes (66 percent). Among all the food studied, chocolate was significantly the most craved food by women (79 percent) when compared to other food items (Hill & Heaton-Brown, 1994). When chocolate craving was measured in 97 women, (Hormes & Timko, 2011) found that in 28.9 percent of the subject’s chocolate craving was related to menstrual cycle, and 67.9 percent of menstrual cycle craving was during the luteal phase. On the other hand, when the levels of depression and anxiety of the menstrual and non-menstrual carvers were compared, it was found that there was no significant difference between both groups (p> 0.05). Menstrual cravers were characterized by having more weight fluctuation, more guilt associated with their craving, and more dietary restriction (Hormes & Timko, 2011). The link between chocolate craving and menstrual cycle was also examined by (Hormes & Timko, 2011). By measuring 97 women, 29 percent of them have reported menstrual linked chocolate craving, and most of the cravings were
seen during premenstrual phase. In this study, food craving was associated with less weight satisfaction and low dietary control.

Ye et al., 2010 measured the food craving during menstrual cycle in women complaining of premenstrual dysphoric disorder (PMDD). Food craving in PMDD women was significantly higher than the control group. The craving was higher in the high sweet-fat food category, specifically during the luteal phase. Positive emotions were linked to consumption of the craved food in PMDD subjects (Yen, Chang, Ko, Yen, Chen, Yeh & Chen, 2010). Another study asked 37 women to taste different food items and to rate them into three categories (sweet, salty, bland). The consumption of the sweet category that contained (chocolate, coffee, gum, and cake) was significantly higher than salty and bland categories. There was significantly higher consumption of sweets during the luteal phase (p <0.01) when compared with the follicular phase. It was found also that high levels of estrogen and progesterone were associated to increase consumption of sweet foods (Bowen & Grunberg, 1990).

Yen et al., 2010 considered that the process of food craving to be a response from the women’s body to the increase level of energy expenditure or to dietary deficiency. Also, it is considered to be a result of hormonal fluctuation during menstrual cycle, or a response to negative emotions and stress (Yen et al., 2010).

**Premenstrual Syndrome (PMS)**

PMS occurs before menstruation, mainly during the luteal phase and ends with the first day of the menstrual phase (Usman, Indusekhar & O'Brien, 2008). In order for the woman to be diagnosed with premenstrual syndrome (PMS), she should experience
more than one sign of the ACOG (American college of obstetrics and gynecologists) PMS diagnostic criteria list (Rapkin, 2003). These criteria are divided into two categories. First, affective which includes depression, angry mood, irritability, confusion, and social problems. Second somatic which includes headache, extremities swelling, bloating in the abdominal area and tenderness in the breast (Rapkin, 2003). When the physical, psychological, and behavioral symptoms of the PMS became severe, this is known as premenstrual dysphoric disorder (PMDD) (Usman, Indusekhar & O'Brien, 2008). To be diagnosed with PMDD, women should experience five or more of the PMS symptoms (Milewicz & Jedrzejuk, 2006). There is no specific cause of the PMS (Milewicz & Jedrzejuk, 2006). However, some of the proposed causes are low concentration of progesterone during the luteal phase, dysfunction in the hypothalamus-pituitary-adrenal axis which affects neurotransmitter production, low calcium and magnesium intake, high body weight, and some psychological factors such as stress (Milewicz & Jedrzejuk, 2006). Many pharmacologic methods have been suggested to treat and prevent the PMS such as dietary modification, exercise, stress management, and cognitive behavior therapy (Rapkin, 2003). Serotonin reuptake inhibitor (SSRI) such as fluxetine and sertaline were suggested by the ACOG for treating PMS (Rapkin, 2003).
CHAPTER III

METHODOLOGY

Purpose

The purpose of this study was to measure dietary changes and food craving between different phases of the menstrual cycle in normal menstruating women attending Kent State University in Kent Ohio. The research was approved by Kent State University institutional Review Board (IRB). The followings are the research hypothesis: I. There is changes in dietary intake during the menstrual cycle. II. Women experience food cravings during menstrual cycle.

Design

The research design was a descriptive, quantitative comparative analysis of the participant’s dietary intakes and food cravings through the three different menstrual cycle phases. The independent variables were the menstrual cycle phases (menstrual phase, follicular phase, and luteal phase). Dependent variables were dietary intake, including Calories and macronutrients (carbohydrates, proteins, and fat), amount of macronutrients (grams), and total energy intake (Kcal).

Subjects

Participants were recruited using a convenience sample of women affiliated in Kent State University, in Kent Ohio. The inclusion criteria were women attending Kent State University, between the ages of 18 to 40 years, and having normal menstrual cycles (menstrual cycle that occurs every 25 to 35 days). Exclusion criteria were using exogenous hormones (oral contraceptives, injections, implant), used oral contraceptives
for the past six months or planning to use it for the next two months, planning to get
pregnant in the next two months, having irregular menstrual cycles (less than 25 days or
more than 35 days), using medications that affect their appetite, reporting psychological,
medical condition that interfere with normal menstruation, having high rate of eating
disorder (score of more than 20 in the EAT-26), complaining of PMDD, intensive
exercise (more than seven hours per week), having high or low body weight (BMI less
than 18, or more than 25).

**Instruments of Measure**

An online survey was used to determine the eligible subjects to participate in the
study.

**Pre Assessment Phase**

The Pre Assessment Phase consists of four sections:

1) *Health History Questionnaire* (Appendix B). This was used to measure age, weight,
height, BMI (kg/m²), exercise intensity (hours/week), menstrual cycle pattern (length
of the cycle), usage of oral contraceptives (yes, no), the presence of any medical
condition that interfere with the menstrual cycle. The questionnaire can be found in
appendix B.

2) *Eating Attitude Test-26 (EAT-26)* was used to detect the signs of eating disorders
(Garner et al., 1982). The EAT-26 consists of 26 questions that are answered based
on a six-point Likert-Scale (Always = 3 points, usually = 2 points, often = 1 point,
sometimes, rarely and never = 0). This test covers four areas: dieting behaviors,
bulimia, preoccupation with food and oral control. A score of 20 or higher on this test
indicates concern about eating habits. This can be found in appendix C part A. The second part of the EAT-26 consists of 5 questions that measure the eating behavior using a Likert scale (Never, once a month or less, two to three times a month, once a week, two to six times a week, once a day or more). The scoring and interpretation for the EAT-26 can be found in appendix C part B. The permission for using this test can be found in Appendix C part C.

3) *The Mental and Physical Symptom Daily Rating Scale* (appendix D part A) was used to measure the severity of PMS and PMDD symptoms. This scale consists of 28 questions that focus on 3 categories: questions 1 to 12 focuses on the mental symptoms, questions 13 to 21 focus on the physical symptoms, questions from 22 to 28 are miscellaneous information. The scoring that describes the severity of the symptoms is rated with four levels (3 = severe, 2 = moderate, 1 = slight, and 0 = not at all) (Dhar & Pearson Murphy, 1990). Scoring one or more of the severe symptoms for two menstrual cycles is an initial diagnosis of PMS, while scoring 5 or more of the severe symptoms will be considered as having PMDD (Freeman, 2003). Participants who fall in the PMDD category were excluded from the study. The permission for using this survey can be found in appendix D part B.

4) *Food craving questionnaire* (Appendix E part A). This survey was used to measure the past food craving experience, type and frequency of the craving and whether it is linked to the emotional status and to the menstrual cycle (Weingarten & Elston, 1991). The permission for using this survey can be found in Appendix E part B.
Assessment Phase

After completing the pre-assessment phase, eligible participants proceeded to the assessment phase where six measurement methods were used:

1) *The menstrual cycle tracking record:* was used to record the beginning and ending date of each phase of the cycle. The menstrual phase begins with the first day of bleeding and ends by the end of bleeding. Second is the follicular phase, which begins with the end of menstrual phase and ends with ovulation. Third is the luteal phase, which begins with ovulation and ends with the first day of the next menses. This process was repeated twice as each subject completed two cycles. This record helps to measure the length of each phase and cycle and make sure that each cycle was within the normal range (25-35 days). The menstrual cycle tracking record can be found in appendix F.

2) *Ovulation test:* the process of ovulation was detected using a urinary test to measure Luteinizing hormone (LH) surge. The LH surge detection kit (Easy @Home ovulation test) with the instructions was provided to each participant. It was suggested that the ovulation is expected to occur from day eight to 18 from beginning of menstruation (McVay, Copeland, Newman & Geiselman, 2012). Each participant was given 10 ovulation strips per cycle. A positive test indicates the end of the follicular phase and the beginning of the luteal phase. Detecting ovulation by measuring urinary LH surge is considered to be a valid and reliable method (Rudy, Ellen & Patricia, 1992).
3) **Food Record**: this was used to measure the food intake of each subject (Appendix G). An instruction sheet that includes guideline of how to record the daily food intake was provided to the participants. The food record is derived from (Ha, & Caine-Bish, 2009). Each subject completed three days food required for each phase for two months (three during the menstrual phase, three during the follicular phase, and three during the luteal phase). At the end, each subject has a total of 18 food records. The recorded dietary intake was analyzed using Food Processor SQL (Version 10.8, year 2011; ESHA Research, Salem, OR).

4) **Craving Screening**: with each food record, participants completed a food craving survey that included the following: a) 100mm Visual Analog Scale (VAS) to measure the appetite, hunger, and mood status. This was derived from (McVay, Copeland, Newman & Geiselman, 2012). The Visual analog scale is considered a valid method in measuring appetite (Stubbs, Hughes, Johnstone, Rowley, Reid, Elia, & Blundell, 2000) and mood (Monk, 1989). b) An initial food craving questionnaire that was derived from (Cohen, Sherwin & Fleming, 1987). This was used to measure the craving type and intensity. Each participant completed nine craving screening survey per cycle.

5) **Food Craving Record**: The food cravings during menstrual cycle will be measured using a Craving Record by (Massey & Hill, 2012) (Appendix H part A). Participants completed this form every time they have a craving episode whether they consume the craved item or not. The Craving Record consists of questions about the location, triggers and time of the caving experience. Visual analogue scale (100 mm) was used
in order to measure the hunger level and the intensity of the craving episode (strength, difficulty resisting, target food restriction, and speed of disappearance). Measuring the mood before and after craving was by using the UWIST Mood Adjective Checklist (Matthews, Jones, & Chamberlain, 1990), where three categories for mood status were used and each one contains 4 adjectives (Hedonic tone: happy, sad, dissatisfied, contented), (Tense arousal: nervous, calm, tense, relaxed), (Energetic arousal: sluggish, tired, energetic, alert). Participants were required to choose one of four responses (extremely “3”, moderately “2”, slightly “1”, and not at all “0”). The permission for using this survey can be found in appendix H part B.

6) The Mental and Physical Symptom Daily Rating Scale: similar to the one used in the preassessment phase. The aim was to measure the severity of PMS and PMDD symptoms during the luteal phase. Each participant was given this scale attached to the three day food record in the luteal phase.

Procedure

A web based survey was administered during the spring 2014 semester at Kent State University. Email included the purpose of the study, inclusion and exclusion criteria, the consent form (appendix A) and the preassessment survey was sent to the listserve in the college of education, health and human services graduate program, college of nursing, college of public health, and Kent State Women Center. In addition, flyers were posted in many on campus buildings. The flyers contain information about the purpose of the study, inclusion and exclusion criteria, and contact information of the research investigator. The consent form and the survey were created using Qualtrics Survey
Software. Participants were asked to disclose their name and contact information (email or phone) in order to contact them if they pass the preassessment phase. Eligible participants were contacted through email that contains detail explanation for the assessment phase of the study.

The assessment phase was divided into three parts (menstrual phase follicular phase, and Luteal phase (Appendix I). Each phase has color coded folder that contains the required document to be completed. The investigator conducted three meetings per cycle with each participant to give instructions for the current phase and to take the completed document for the previous phase. The same process was repeated in the second cycle.

_The Menstrual Phase_ was the starting point for each participant. A red folder was given to each subject that contains: 1) Daily menstrual cycle track record, where participants record the dates beginning with the first day of menses until it ends. 2) The Food record, for three consecutive days: 2nd, 3rd, 4th day. 3) A craving screening survey, completed in the same days of the food record. 4) The Craving Record, which was completed when having the craving episode. This phase ends on the last day of menses. Then, participants meet the investigator to take the next phase folder and to submit the red folder.

_The Follicular Phase_ , which follow the menstrual phase, a green folder was given to each subject that contains: 1) Daily menstrual cycle track record, where participants record the dates beginning with the first day of the follicular phase until it ends 2) The Food record, for three consecutive days: 10th, 11th, and ovulation day. 3) A craving screening survey, completed in the same days of the food record. 4) The Craving Record,
which was completed when having the craving episode. 5) LH urine test, to detect ovulation. Ovulation is the indicator for ending the follicular phase and beginning the luteal phase. When the participant gets a positive ovulation test, she records it on the daily menstrual cycle tracking record, contacts the investigator, and exchange folders.

*The Luteal Phase*, which follow the menstrual phase, a blue folder was given to each subject that contains 1) Daily menstrual cycle track record, where participants record the dates beginning with the first day of the luteal phase until it ends 2) The Food record, for three consecutive days: (22th, 23th, and 24th day). 3) A craving screening survey, completed in the same days of the food record. 4) The Craving Record, which was completed when having the craving episode. 5) PMS scale was used to measure the severity of PMS and PMDD. When this phase ends, by the beginning with the next menstrual phase, this was the ending of a complete cycle. Subject submit this folder and start a new cycle, menstrual, follicular and finally luteal phase.

**Data Analysis**

The data was entered by the Kent State University Research Beauru using the social science (SPSS, version21) and significant level of (p≤0.05)

**Pre Assessment Phase**

Health History Questionnaire (age, BMI, menstrual cycle length and frequency, hormonal use, medical status, exercise pattern) was summarized as a descriptive statistics.

EAT-26 was scored as follows, questions 1 to 25 (Always=3, usually =2, often=1, sometimes, rarely, and never =0), question 26 (Always, usually, often=1, sometimes=1,
rarely=2, and never =3). A score of 20 or above indicates a high level of concern regarding eating habits and behavior (Garner et al., 1982). Detailed description for the EAT-26 and the behavioral test can be found in appendix C part B. Data was summarized as a descriptive statistic (frequency and percent concern of ED and No concern for ED) and (frequency and percent behavioral problem and no behavioral problem).

The Mental and Physical Symptom Daily Rating Scale consist of 28 questions where (severe=3, moderate=2, slight=1, and not at all=0). Scoring one or more of the severe symptoms for two menstrual cycles is an initial diagnosis of PMS, while scoring five or more of the severe symptoms will be considered as having PMDD (Freeman, 2003). Data was summarized as descriptive statistics (frequency and percent of PMS and PMDD).

The craving history data (food craving experience, relation to other food, relation to emotion and menstrual cycle) were summarized as descriptive statistics (frequency and percent).

**Assessment Phase**

Food Records were analyzed using the Food Processor Software. Food items were converted into total calories and grams of macronutrients (carbohydrate, protein, and fat). The percentage of daily intake was calculated by dividing the actual intake by the recommended intake and multiplying the result by 100. The recommended energy intake was calculated using the DRI (Dietary Reference Intake) formula Adapted from (Otten, et al., 2006).
EER (Estimated Energy requirement) = 354 - (6.91 x age [years]) + Physical Activity x
[(9.36 x weight [kg]) + (726 x height [ml])]

The recommended macronutrients intake was calculated by the food processor
according to the recommended daily intake (RDI) for carbohydrate, protein and fat,
adapted from (Dietary Reference Intakes for Macronutrients, 2002).

The BMI (Body Mass Index) was calculated by dividing the weight (kg) by height (m²)

Data from the food records were analyzed using Rpeated Measure Analysis of
Variance (RM ANOVA) to compare the percentage of calories, fat, carbohydrates and
protein in subjects’ diets between the 3 phases of the cycle (menstrual, follicular, and
luteal).

Data from the Craving Screening test was analyzed using 3 (phases M,F,L) by 2
(craving vs non craving) ANOVA to see whether a difference exists between the cravers
and non-cravers in (hunger, satiety, stress, relaxation, anxiety, rate of craving, consuming
the food, breaking regular diet, and eating as usual) and also between the 3 phases.

Data from the Craving Records were analyzed using Repeated Measures Analysis
of Variance (RM ANOVA) to compare (the hedonic tone, tense arousal, energetic arousal
hunger level, strength and pleasantness of craving, resisting the craving) between pre and
post craving and across the three phases. Also simple analysis of variance was used to
compare between the three phases in the strength of craving and restricting the craved
food.
CHAPTER IV
JOURNAL ARTICLE

Introduction

Each month, women during the reproductive age will have a menstrual cycle (Goodman, 2003; Levy & Lightman, 1997) that lasts 28 days on average (Carr & Blackwell, 1993; Barbieri, Jaffe & Yen, 1999; Silberstein & Merriam, 2000). During the menstrual cycle, women’s body will experience physiological and psychological fluctuations (Rapkin, 2003) this might have a great impact on the quality and quantity of the food consumed, therefore, cause an imbalance in diet pattern. Approximately 74 percent of women experience food cravings during the menstrual cycle (Dye, Warner & Bancroft, 1995).

Balanced and healthy diet is essential to maintain healthy body weight, however, many researchers found that appetite and dietary intake are affected during different phases of the menstrual cycle (Dye & Blundell, 1997). Essentially, the proposed cause of changing dietary intake was hormonal fluctuations, primarily estrogen and progesterone (Howe, Rumpler & Seale, 1993). The elevation in progesterone level during the luteal phase was found to be associated with an increase in food intake, while elevation estrogen level during the follicular phase was found to be associated with decrease food intake (Dalvit-McPhillips, 1983; Johnson, Corrigan, Lemmon, Bergeron & Crusco, 1994; Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988).

The dietary intake was studied and measured by analyzing the macronutrients intake (carbohydrate, fat, and protein) and the total energy intake throughout various
phases of the menstrual cycle (Tarasuk & Beaton, 1991; Lyons, Truswell, Mira, Vizzard & Abraham, 1989; Lissner, Stevens, Levitsky, Rasmussen & Strupp, 1988; Gong, Garrel & Calloway, 1989). The common findings between these studies were an increase in dietary consumption during the luteal phase when compared to the menstrual and the follicular phase.

The cravings of food were investigated by measuring the intensity rate and type of food items that is craved. Many opinions have been proposed about the food craving phenomenon, some researchers considered the process of food craving to be a response from the women’s body to the increase level of energy expenditure or to dietary deficiency (Yen et al., 2010), while others associated it to hormonal and psychological changes during menstrual cycle (Cohen, Sherwin, Fleming, 1987), though, Rabinovitz (2005) suggested that craving for particular food is mainly results from psychological purpose to relief intense desire for that food in addition to stress or tension. Moreover, several studies have linked the episodes of food craving during the menstrual cycle with psychological conditions such as depression, PMS, and PMDD (Dye, Warner & Bancroft, 1995; Yen, Chang, Ko, Yen, Chen, Yeh & Chen, 2010; Smith & Sauder, 1969).

Comparing to the menstrual and follicular phase, the luteal phase tend to have the highest craving episodes, and chocolate was found to be among the most craved food items (Hill & Heaton-Brown, 1994; Hormes & Timko, 2011). During the menstrual cycle, women who have high craving episodes found to have low control of body weight and feeling of guilt associated with the craving process (Hormes & Timko, 2011).
The aim of this study was to determine if dietary changes and food cravings occur during the menstrual cycle. The hypotheses were 1) There is a change in dietary intake during the menstrual cycle, and 2) Women experience food cravings during menstrual cycle.

**Methodology**

The research design was a descriptive, quantitative comparative analysis of the participant’s dietary intakes and food cravings through the three different menstrual cycle phases.

**Design**

The independent variables were the menstrual cycle phases (menstrual phase, follicular phase, and luteal phase). The dependent variables were dietary intake, energy consumption (Kcal) and macronutrients (carbohydrates, proteins, and fat).

**Participants**

Participants were recruited using a convenience sample of women (students, faculty, and staff) attending Kent State University, in Kent Ohio. The inclusion criteria were women between the age of 18 to 40 years, and having normal menstrual cycles (25 to 35 day cycle). Exclusion criteria were using or used exogenous hormones in the past 6 months (oral contraceptives, injections, implant), or planning to use it for the next 2 months, planning to get pregnant in the next two months, irregular menstrual cycles (<25, >35 days), using medications that affect appetite, reporting psychological or medical condition that interfere with normal menstruation, having high rate of eating disorder
(score of >20 in the EAT-26), complaining of PMDD, intensive exercise (more than 7 hours per week), having high or low body weight (BMI <18, or >25).

**Measures**

An online survey was used as an initial screening test to determine the eligible subjects to participate in the study.

**Pre assessment phase.** The pre assessment phase consists of four sections:

1) **Health History Questionnaire** was used to measure age, weight, height, BMI (kg/m2), exercise intensity (hours/week), menstrual cycle pattern (length and frequency of the cycle), usage of oral contraceptives, and the presence of any medical condition that interfere with the menstrual cycle.

2) **Eating Attitude Test-26 (EAT-26)** was used to detect the signs of eating disorders (Garner et al., 1982). The EAT-26 consists of 26 questions that are answered based on a six-point Likert-Scale (Always =3 points, usually = 2 points, often =1 point, sometimes, rarely and never = 0). This test covers four areas: dieting behaviors, bulimia, preoccupation with food and oral control. A score of 20 or higher on this test indicates concern about eating habits. The second part of the EAT-26 consists of five questions that measures the eating behavior using a Likert scale (Never, once a month or less, two to three times a month, once a week, two to six times a week, once a day or more).

3) **The Mental and Physical Symptom Daily Rating Scale** was used to measure the severity of PMS and PMDD symptoms (Dhar & Pearson Murphy, 1990). This scale consists of 28 questions that focus on three categories: questions 1 to 12 focus on the
mental symptoms, questions 13 to 21 focus on the physical symptoms, questions from 22 to 28 are miscellaneous information. The symptoms were rated based on five points Likert-Scale (severe, moderate, slight, and not at all). Scoring one or more of the severe symptoms for two menstrual cycles is an initial diagnosis of PMS, while scoring five or more of the severe symptoms will be considered as having PMDD (Freeman, 2003). Participants who fall in the PMDD category were excluded from the study.

4) A food craving questionnaire used to measure the past food craving experience, type and frequency of the craving and whether it is linked to the emotional status and to the menstrual cycle (Weingarten & Elston, 1991).

Assessment phase. This is the second part of the study where eligible participants started recoding their food diary and cravings, and also tracking their menstrual cycle every day for two consecutive months. During this stage, six measurement methods were used:

1) The Menstrual Cycle Tracking Record was used to record the beginning and ending date of each phase of the cycle. The menstrual phase begins with the first day of bleeding and ends by the end of bleeding. The follicular phase begins with the end of menstrual phase and ends with ovulation. The luteal phase begins with ovulation and ends with the first day of the next menses. This process was repeated twice as each subject completed two cycles. This record helps to measure the length of each phase and cycle and make sure that each cycle was within the normal range (25-35 days).
2) *LH test* is a urine test that measures Luteinizing hormone (LH) surge and this was used to detect the process of ovulation. The LH surge detection kit (Easy @Home ovulation test) with the instructions were provided to each participant. It was suggested that the ovulation is expected to occur from day 8 to 18 from beginning of menstruation (McVay, Copeland, Newman & Geiselman, 2012). Each participant was given 10 ovulation strips per cycle. A Positive test indicates the end of the follicular phase and the beginning of the luteal phase. Detecting ovulation by measuring urinary LH surge is considered to be a valid and reliable method (Rudy, Ellen & Patricia, 1992).

3) *The Food Record* derived from (Ha, & Caine-Bish, 2009), was used to measure the food intake of each subject. Each subject completed 3 days food record per phase for two months (three during the menstrual phase, three during the follicular phase, and three during the luteal phase). At the end, each subject submitted a total of 18 food records. The recorded dietary intake was analyzed using Food Processor SQL (Version10.8, year 2011; ESHA Research, Salem, OR).

4) *The Craving Screening*, with each food record, participants completed a food craving survey that included the following: 100mm Visual Analog Scale (VAS) that measured appetite, hunger, and mood status, this was derived from (McVay, Copeland, Newman & Geiselman, 2012). The Visual analog scale is considered a valid method in measuring appetite (Stubbs, Hughes, Johnstone, Rowley, Reid, Elia, ... & Blundell, 2000) and mood (Monk, 1989). In addition to the VAS, an initial food craving
questionnaire was used to measure the craving type and intensity (Cohen, Sherwin & Fleming, 1987). Each participant completed 9 craving screening surveys per cycle.

5) *The Food Craving Record* was used to detect craving episodes (Massey & Hill, 2012). Subjects completed this form every time they had a craving episode whether they consume the craved item or not. This Record consists of questions about the location, triggers and time of the craving experience. Visual analogue scale (100 mm) was used in order to measure the hunger level and the intensity of the craving episode (strength, difficulty resisting, target food restriction, and speed of disappearance). Measuring the mood before and after craving was by using the UWIST Mood Adjective Checklist (Matthews, Jones, & Chamberlain, 1990), where three categories for mood status were used and each one contains 4 adjectives (Hedonic tone: happy, sad, dissatisfied, contented), (Tense arousal: nervous, calm, tense, relaxed), (Energetic arousal: sluggish, tired, energetic, alert). Participants were required to choose one of four responses (extremely “3”, moderately “2”, slightly “1”, and not at all “0”).

6) *Mental and Physical Symptom Daily Rating Scale* is the same PMS/PMDD scale that was used during the pre-assessment phase. The aim was to measure the severity of PMS and PMDD symptoms during the luteal phase. Each participant was given this scale attached to the 3 day food record in the luteal phase.
Procedure

During the spring 2014 semester at Kent State University, emails were sent to the listserve in many colleges and also to the women's center. In addition, flyers were posted in many on campus buildings.

**Pre assessment phase.** Both emails and flyers contain the purpose of the study, inclusion and exclusion criteria, and contact information of the research investigator to contact if interested to participate in the study. The email already attached with links of the consent form and the preassessment survey that were created using Qualtrics Survey Software. Participants were asked to disclose their name and contact information (email or phone) in order to contact them if they pass the preassessment phase. Eligible participants were contacted through email that contains a detailed explanation for the assessment phase of the study.

After completing the Preassessment online survey, data were analyzed and each participant who met all the following criteria was contacted by email to further describe the second part of the study, the general criteria were: women age between 18 to 40 years, normal menstrual cycles not using exogenous hormones, not using medications or complaining of medical problem that interfere with normal cycle and appetite, normal BMI, normal EAT-26 and PMS scores and not participating in sport that require intense exercise. Eligible participants must satisfy all the previous criteria. Participants who failed to meet these criteria were excluded from proceeding to the next phase.

**Assessment phase.** Eligible participants received email that they passed the first stage of the study, the email contains detailed explanations about the second stage and
also a list of dates to schedule appointments with the investigator for further explanation and to take the documents required to complete in the first phase of the cycle.

The assessment phase was divided into three parts (menstrual phase, follicular phase, and luteal phase). Each phase has color-coded folder that contains the required document to complete. The investigator conducted three meetings per cycle with each participant to give them instructions about current phase and to take the completed document for the previous phase, each meeting lasts about 10-20 minutes. The same process was repeated in the second cycle.

1) **The Menstrual Phase** was the starting point for each participant. A red folder was given to each subject that contains: 1) Daily menstrual cycle track record, where participants record the dates starting with the first day of menses until it ends. 2) The Food record, for three consecutive days: 2\(^{nd}\), 3\(^{rd}\), 4\(^{th}\) day of the cycle. 3) A craving screening survey, completed in the same days of the food record. 4) The Craving Record, which was completed when having the craving episode. This phase ends on the last day of menses. Then, participants meet the investigator to submit current phase folder and to take the next one.

2) **The Follicular Phase** follows the menstrual phase, a green folder was given to each subject that contains: 1) Daily menstrual cycle track record, where participants record the dates beginning with the first day of the follicular phase until it ends. 2) The Food record, for three consecutive days: 10\(^{th}\), 11\(^{th}\), and ovulation day. 3) A craving screening survey, completed in the same days of the food record. 4) The Craving Record, which was completed when having the craving episode. 5) LH urine test, to detect
ovulation. Ovulation was used as an indicator for ending the follicular phase and beginning the luteal phase. When the participant gets a positive ovulation test, she records it on the daily menstrual cycle tracking record, contacts the investigator, and exchange folders.

3) **The Luteal Phase** follows the follicular phase, a blue folder was given to each subject that contains 1) Daily menstrual cycle track record, where participants record the dates beginning with the first day of the luteal phase until it ends 2) The Food record, for three consecutive days: 22\textsuperscript{th}, 23\textsuperscript{th}, and 24\textsuperscript{th} day of the cycle. 3) A craving screening survey, completed in the same days of the food record. 4) The Craving Record, which was completed when having the craving episode. 5) PMS scale was used to measure the severity of PMS and PMDD. This phase ends, by the beginning with the next menstrual phase, which mean completing full cycle. Participants submit this folder and start a new cycle, menstrual, follicular and finally luteal phase.

**Data Analysis**

The data were entered by Kent State University Research Bureau using the social science (SPSS, version 21) and significant level of (p ≤ 0.05).

**Pre Assessment Phase**

Data from the following measurement methods were analyzed using descriptive statistics:

1) **Health History Questionnaire** (age, BMI, menstrual cycle length and frequency, hormonal use, medical status, exercise pattern). The BMI (Body Mass Index) was calculated by dividing the weight (kg) by height (m\textsuperscript{2})
2) *EAT-26* was scored as follows, questions 1-25 (Always=3, usually =2, often=1, sometimes, rarely, and never =0), question 26 (Always, usually, often=1, sometimes=1, rarely=2, and never =3). A score of 20 or above indicates a high level of concern regarding eating habits and behavior (Garner et al., 1982). Data was summarized as (frequency and percent concern of ED and No concern for ED) and (frequency and percent behavioral problem and no behavioral problem).

3) *The Mental and Physical Symptom Daily Rating Scale* consist of 28 questions where participants rated each symptom as (severe, moderate, slight, or not at all). Scoring one or more of the severe symptoms for two menstrual cycles is an initial diagnosis of PMS, while scoring five or more of the severe symptoms will be considered as having PMDD (Freeman, 2003). Data was summarized as (frequency and percent of PMS and PMDD).

4) *The craving history data* (food craving experience, relation to other food, relation to emotion and menstrual cycle) were summarized as (frequency and percent).

**Assessment Phase**

Data from the following measurement methods were analyzed using Repeated Measures Analysis of Variance (RM ANOVA):

1) The food records, to compare the percentage (%) of calories, fat, carbohydrates and protein across the three phases of the cycle (menstrual, follicular, and luteal) Food Records were analyzed using the Food Processor Software, Food Processor SQL (Version10.8, year 2011; ESHA Research, Salem, OR).
Food items were converted into total calories and grams of macronutrients (carbohydrate, protein, and fat). The percentage of daily intake was calculated by dividing the actual intake by the recommended intake and multiplying the result by 100. This was used to measure how many percent of energy and macronutrients each participant was consuming of their recommended intake. The Food Processor Software determined the energy requirement for each participant based on the DRI (Dietary Reference Intake) formula Adapted from: (Otten, et al.,2006). EER (Estimated Energy requirement) = 354 - (6.91 x age [years]) + Physical Activity x [(9.36 x weight [kg]) + (726 x height [ml])]

The recommended macronutrients intake was calculated by the food processor according to the recommended daily intake (RDI) for carbohydrate, protein and fat, adapted from (Dietary Reference Intakes for Macronutrients, 2002).

2) The Craving Records, to compare (hedonic tone, tense arousal, energetic arousal hunger level, strength and pleasantness of craving, resisting the craving) between pre and post craving and across the 3 phases.

Data from the following measurement methods were analyzed using Simple Analysis of Variance (ANOVA):

3) The Craving Records, to measure the strength of craving, restricting the craved food, difficulty to resist the craving, pleasantness of craved food, and the quick of disappearance of craving. All these criteria were measured across the three phases of the cycle.
Results

A convenience sample of sixty KSU women (N=60) participated in the initial part of the study.

Pre Assessment Phase

Table 1 shows the participants’ demographics. The majority of women age was

Table 1

Female Participant Delographics Characteristics (Age, Weight Status, Menstrual Cycle Status) During the Pre Assessment Phase of the Study (N=60)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group(years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-20</td>
<td>11</td>
<td>18.0</td>
</tr>
<tr>
<td>21-30</td>
<td>40</td>
<td>65.6</td>
</tr>
<tr>
<td>31-40</td>
<td>8</td>
<td>13.1</td>
</tr>
<tr>
<td>&gt;40</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>BMI a (kg/m²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤18.4 (underweight)</td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td>18.5-24.9 (normal)</td>
<td>45</td>
<td>75.0</td>
</tr>
<tr>
<td>25-29.9 (over weight)</td>
<td>6</td>
<td>10.0</td>
</tr>
<tr>
<td>≥30 (obese)</td>
<td>7</td>
<td>11.7</td>
</tr>
<tr>
<td>Normal menstrual cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>52</td>
<td>85.2</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>13.1</td>
</tr>
<tr>
<td>Days between two cycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-24</td>
<td>6</td>
<td>9.8</td>
</tr>
<tr>
<td>25-29</td>
<td>32</td>
<td>52.5</td>
</tr>
<tr>
<td>30-35</td>
<td>18</td>
<td>29.5</td>
</tr>
<tr>
<td>36-40</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Varies</td>
<td>3</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Note. a BMI: (Body Mass Index) classification was adapted from the World Health Organization http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

Preassessment phase: is the initial stage of the study where the participants tested to see if they were eligible to be included in the second stage of the study which is the assessment phase.
between 21 to 30 years (n=40, 65.6%), had normal body weight (n=45, 75.0%) and reported normal menstrual cycle (n=52, 85.2%) with 25 to 29 day period between cycles (n=32, 52.5%). Table 2 shows the factors that suggested to interfere with normal menstrual cycle. Most women participate in regular exercise (n=43, 70.5%), and they do not follow a strict exercise regimen, with an average 175.70 minutes of sport training per week (SD=115.58), while only (n=4, 6.6%) of women participate in sports that require

**Table 2**

*Factors Measured during the Pre Assessment Phase that may Interfere with Normal Menstrual Cycling, and were used to Exclude Women Not Eligible to Participate in the Study (N=60)*

<table>
<thead>
<tr>
<th>Factors</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>43</td>
<td>70.5</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>26.2</td>
</tr>
<tr>
<td>Sport Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>6.6</td>
</tr>
<tr>
<td>No</td>
<td>56</td>
<td>91.8</td>
</tr>
<tr>
<td>Hormonal contraceptive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>9.8</td>
</tr>
<tr>
<td>No</td>
<td>54</td>
<td>88.5</td>
</tr>
<tr>
<td>Plan for pregnancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5</td>
<td>8.2</td>
</tr>
<tr>
<td>No</td>
<td>55</td>
<td>90.2</td>
</tr>
<tr>
<td>Medication affects appetite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td>No</td>
<td>58</td>
<td>95.1</td>
</tr>
<tr>
<td>Medication affects cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>No</td>
<td>59</td>
<td>96.7</td>
</tr>
<tr>
<td>Disorder affects appetite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>60</td>
<td>98.4</td>
</tr>
<tr>
<td>Disorder affects cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>60</td>
<td>98.4</td>
</tr>
</tbody>
</table>
strict training. The majority of them did not report having any medical or psychological condition or using medications that affect appetite or interfere with regular menstrual cycle. In addition, most of them did not use hormonal contraceptive or plan for pregnancy in the next 2 months. Table 3 shows the eating disorder and premenstrual syndrome scores. EAT-26 test shows that most women didn’t have a high score that indicates concern for eating disorder (n=52, 85.2%) and only (n=7, 11.5%) had a score of (≥20) that raise the concern for eating disorder. For the eating behavior section (n=44, 72.1%) were normal and (n=15, 24.6%) showed a score level of behavior problem that indicate subjects to be referred to trained mental health professional for consultation. The third part was the premenstrual syndrome test that shows the majority of participants reported at least one severe symptoms during the 10 days prior the menstrual phase (n=54, 88.5%), where (n=7, 11.5%) reported more than five severe symptoms, therefore, fall in the PMDD category.

A total of 52 participants completed the craving history survey, which was the last section of the initial screening. Table 4 shows that the majority of participants has experienced food craving (n=46, 75.5%). The majority responded that there is no food, other than the craved food, would satisfy the craving (n=37, 72.5%), and most participants responded that 50 percent of the time they will follow their craving and eat the craved food. When they were asked about their feeling when they eat the craved food, the majority (n=25, 41%) responded they feel satisfied. When they were asked if they feel that the craving is related to their menstruation 36 percent (n=18) responded it is
sometimes related, and 20 (n=10) percent responded that it is always related to the menstrual cycle.

Table 3

*Preassessment Screening for Eating Disorders and Premenstrual Syndrome Scores that Determines Participants Eligibility to Continue the Study (N=60)*

<table>
<thead>
<tr>
<th>Test</th>
<th>Criteria</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAT-26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>No concern for ED</td>
<td>52</td>
<td>85.2</td>
</tr>
<tr>
<td></td>
<td>Concern for ED</td>
<td>7</td>
<td>11.5</td>
</tr>
<tr>
<td>EAT-26 Behavior&lt;sup&gt;c&lt;/sup&gt;</td>
<td>No behavioral problems</td>
<td>44</td>
<td>72.1</td>
</tr>
<tr>
<td></td>
<td>Behavioral problems</td>
<td>15</td>
<td>25.4</td>
</tr>
<tr>
<td>Premenstrual syndrome&lt;sup&gt;d&lt;/sup&gt;</td>
<td>PMS</td>
<td>54</td>
<td>88.5</td>
</tr>
<tr>
<td></td>
<td>PMDD</td>
<td>7</td>
<td>11.5</td>
</tr>
</tbody>
</table>

EAT-26 scoring: is when the sum of the scores is 20 or more, this indicates a high level of concern about dieting, body weight, or problematic eating behavior. Adapted from (Garner et al., 1982)

EAT-26 Behavior questions: choosing one or more of the checked boxes this indicates that participant should seek an evaluation from a trained mental health professional.

ED: Eating disorder.

PMS (Premenstrual syndrome) and PMDD (Premenstrual dysphoric disorder) scale was adapted from: (Dhar & Pearson Murphy, 1990)

Scoring one or more of the severe symptoms indicates PMS, while scoring more than five severe symptoms indicates PMDD.
Table 4

*Craving History Questionnaire during the Pre-Assessment Phase (N=52)*

<table>
<thead>
<tr>
<th>Experiences</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experienced food craving</td>
<td>Yes</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>6</td>
</tr>
<tr>
<td>Other food would satisfy craving</td>
<td>Yes</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>37</td>
</tr>
<tr>
<td>How often do you eat the craved food</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>Feeling when ate craved food</td>
<td>Dissatisfied</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Somewhat dissatisfied</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Somewhat satisfied</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Satisfied</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Very satisfied</td>
<td>14</td>
</tr>
<tr>
<td>Craving related to the menstrual cycle</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Rarely</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Often</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Usually</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>10</td>
</tr>
</tbody>
</table>
Assessment Phase

Of the 60 women who completed the initial survey, only 18 were eligible to proceed and start the assessment phase. Reasons for exclusion were (age >40 or <18, abnormal BMI ≤18.4 or ≥25, abnormal menstrual cycle <25 or >35 days, follow a strict exercise pattern, use hormonal contraceptives, plan to get pregnant, complain of any medical or psychological condition or using medications that affect appetite or menstrual cycle, score ≥20 in the EAT-26 or check any of the categories in the eating behavior test that require health consultation, and fall into the PMDD category. In addition, some participants who were eligible to participate decided not proceed to the assessment phase.

Eligible participants’ characteristics. Table 5 summarizes the characteristics of participants who satisfied the criteria to participate in the second part of the study. The majority of the women’s age group was between 21 to 30 year (n=12, 66.6%). All participants had normal BMI and normal menstrual cycle, does not use hormonal contraceptives, medication or had medical illness that affects appetite or menstrual cycle, and had normal EAT-26 score. None of them fell into the PMDD category, while only (n=7, 38.8%) fell into the PMS category. Most of the participants were engaging in regular exercise (n=15, 83.3%) and none of them were participating in a sport that required intense training.
Table 5

*Eligible Participant Characteristics (Health History Questionnaire, and PMS Scale)*

*(N=18)*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-20</td>
<td>4</td>
<td>22.2</td>
</tr>
<tr>
<td>21-30</td>
<td>12</td>
<td>66.6</td>
</tr>
<tr>
<td>31-40</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>18.5-24.9 (normal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days between two cycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td>13</td>
<td>72.2</td>
</tr>
<tr>
<td>30-35</td>
<td>5</td>
<td>27.7</td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15</td>
<td>83.3</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>16.6</td>
</tr>
<tr>
<td>Premenstrual syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS</td>
<td>7</td>
<td>38.8</td>
</tr>
<tr>
<td>PMDD</td>
<td>0</td>
<td>00.0</td>
</tr>
</tbody>
</table>

**Food record.** Table 6 shows the average percentage of energy and macronutrients (carbohydrates, protein, and fat) across the three phases of the cycle. No significant differences were found between the three phases (*P* >0.05). Table 7 shows the mean intake of kilocalories, grams of macronutrients across that three phases.
Table 6

*Food Record Data are Summarized as Mean (M) and Standard Deviation (SD) of the Percent of Recommended Intake of Energy and Macronutrients during the Three Phases of Menstrual Cycle (N=14)*

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Phase</th>
<th>M</th>
<th>SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (%)</td>
<td>Menstrual</td>
<td>69.58</td>
<td>21.05</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>62.58</td>
<td>14.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>63.01</td>
<td>14.68</td>
<td></td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>Menstrual</td>
<td>64.80</td>
<td>21.22</td>
<td>0.833</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>63.08</td>
<td>15.60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>61.71</td>
<td>18.98</td>
<td></td>
</tr>
<tr>
<td>Protein (%)</td>
<td>Menstrual</td>
<td>132.48</td>
<td>30.29</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>132.16</td>
<td>47.89</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>123.35</td>
<td>41.48</td>
<td></td>
</tr>
<tr>
<td>Fat (%)</td>
<td>Menstrual</td>
<td>77.50</td>
<td>21.25</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>67.44</td>
<td>21.66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>70.28</td>
<td>17.75</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Percent of recommended intake was calculated by dividing the actual intake by the recommended daily intake multiplied by 100.
Table 7

Food Record Data Summarized as Mean (M) and Standard Deviation (SD) of Energy (kcal) and Mean Grams of Carbohydrates, Mean Grams of Protein, and Mean Grams of Fat during the Three Phases of Menstrual Cycle (N=84)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Phase</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>Menstrual</td>
<td>28</td>
<td>1717.01</td>
<td>460.80</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>30</td>
<td>1490.55</td>
<td>402.31</td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>25</td>
<td>1497.27</td>
<td>347.61</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>83</td>
<td>1569.00</td>
<td>416.93</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>Menstrual</td>
<td>28</td>
<td>220.77</td>
<td>65.67</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>30</td>
<td>202.91</td>
<td>49.51</td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>26</td>
<td>200.63</td>
<td>59.34</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>84</td>
<td>208.16</td>
<td>58.32</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>Menstrual</td>
<td>28</td>
<td>70.97</td>
<td>22.48</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>30</td>
<td>63.16</td>
<td>23.81</td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>26</td>
<td>59.17</td>
<td>19.44</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>84</td>
<td>64.53</td>
<td>22.36</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>Menstrual</td>
<td>28</td>
<td>63.24</td>
<td>20.65</td>
</tr>
<tr>
<td></td>
<td>Follicular</td>
<td>30</td>
<td>52.15</td>
<td>20.83</td>
</tr>
<tr>
<td></td>
<td>Luteal</td>
<td>26</td>
<td>50.32</td>
<td>16.57</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>84</td>
<td>64.53</td>
<td>22.36</td>
</tr>
</tbody>
</table>
**Food craving record.** Table 8 shows the results of the food craving records. These records were completed by participants when they experience a craving episode throughout the cycle, whether they ate the craved item or not. The data show that there were more craving records submitted during the menstrual phase. Mood State before and after craving and across the phases was measured as hedonic tone, tense arousal and energetic arousal. There was no significant difference in hedonic tone and energetic arousal, however, tense arousal pre and post craving was highly significant $F(1, 52) = 7.99$, $P=0.007$. The 100mm VAS shows a significant difference in hunger level between pre-craving and post craving with a decrease in hunger level after craving $F(1,56)= 36.03$, $P \leq 0.001$. However, no significant difference was found between the phases.

Strength of craving pre-craving ($M=71.53$, $SD=15.69$) and pleasantness of craved food item post-craving ($M=79.00$, $SD=15.64$) were significantly higher during the follicular phase compared to the other two phases $F(2, 40) =4.24$, $P=0.02$.

Table 9 shows that restricting the craved food was higher during the luteal phase ($M= 59.00$, $SD= 28.96$), however, there was no significant difference with the other phases. The strength of craving was slightly high in all phases, with no significant difference during the cycle. Pleasantness of craved food was found to be significantly different between the follicular and luteal phase with high pleasantness during the follicular phase and lowest during the luteal phase, $F(2) =4.64$, $P=0.15$. 

Table 8.

The Mean Difference of Food Craving Characteristics Pre and Post the Craving Episode across the Three Phases M (Menstrual), F (Follicular), L (Luteal) at Significance Level of $P=0.05$

<table>
<thead>
<tr>
<th>Criteria</th>
<th>n</th>
<th>Phase</th>
<th>M (SD) pre-craving</th>
<th>M (SD) post-craving</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hedonic tone $^a$</td>
<td>21</td>
<td>M</td>
<td>4.85(2.41)</td>
<td>5.33(1.87)</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>F</td>
<td>4.44(2.09)</td>
<td>5.00(2.08)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>L</td>
<td>4.85(2.41)</td>
<td>4.05(1.58)</td>
<td></td>
</tr>
<tr>
<td>Tense arousal $^b$</td>
<td>21</td>
<td>M</td>
<td>3.33(1.52)</td>
<td>2.76(1.44)</td>
<td>0.007*</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>F</td>
<td>3.17(1.70)</td>
<td>2.70(1.44)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>L</td>
<td>3.82(1.87)</td>
<td>3.05(1.56)</td>
<td></td>
</tr>
<tr>
<td>Energetic arousal $^c$</td>
<td>21</td>
<td>M</td>
<td>5.04(2.10)</td>
<td>5.19(2.22)</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>F</td>
<td>4.58(2.18)</td>
<td>5.64(1.80)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>L</td>
<td>5.29(2.08)</td>
<td>5.70(2.86)</td>
<td></td>
</tr>
<tr>
<td>Hunger level $^d$</td>
<td>22</td>
<td>M</td>
<td>51.18(32.10)</td>
<td>32.27(29.27)</td>
<td>$\leq 0.001^*$</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>F</td>
<td>49.94(25.03)</td>
<td>20.23(16.33)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>L</td>
<td>52.90(25.84)</td>
<td>29.10(23.93)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Food Craving Record adapted from Dieting and food craving. A descriptive, quasi-prospective study by (Massey & Hill, 2012).

$^a$ Hedonic tone (happy, sad, dissatisfied, contented), $^b$ Tense arousal (nervous, calm, tense, relaxed), $^c$ Energetic arousal (sluggish, tired, energetic, alert).

* Significance difference at level of significance $P=0.05$

$^d$ 100 mm VAS (visual analog scale) used to measure hunger level, where 0= not hungry at all, and 100= very hungry.
Table 9

The Mean Difference of Food Craving Criteria on a Scale of 100 during the Three Phases of the Menstrual Cycle

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Phase</th>
<th>N</th>
<th>M (SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricting craved item</td>
<td>M</td>
<td>22</td>
<td>37.18(31.05)</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>18</td>
<td>48.83(27.82)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>20</td>
<td>59.00(28.96)</td>
<td></td>
</tr>
<tr>
<td>Strength of craving</td>
<td>M</td>
<td>23</td>
<td>64.47(19.3)</td>
<td>0.873</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>19</td>
<td>65.63(18.90)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>21</td>
<td>62.28(23.59)</td>
<td></td>
</tr>
<tr>
<td>Difficulty to resist craving</td>
<td>M</td>
<td>23</td>
<td>49.08(26.61)</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>19</td>
<td>60.73(26.87)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>21</td>
<td>57.38(25.06)</td>
<td></td>
</tr>
<tr>
<td>Pleasantness of craved food</td>
<td>M</td>
<td>16</td>
<td>72.62(21.63)</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>13</td>
<td>79.00(15.64)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>14</td>
<td>56.14(22.36)</td>
<td></td>
</tr>
<tr>
<td>Quick of disappearance of craved food</td>
<td>M</td>
<td>22</td>
<td>68.90(20.33)</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>17</td>
<td>55.11(26.85)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>20</td>
<td>62.65(23.43)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Food Craving Record adapted from Dieting and food craving. A descriptive, quasi-prospective study by (Massey & Hill, 2012)
M (Menstrual), F (Follicular), L (Luteal).
* Significance difference at level of significance P=0.05
Discussion

The purpose of this study was to measure the dietary intake and food craving between different phases of the menstrual cycle (menstrual, follicular, and luteal phase) in normal menstruating women attending Kent State University in Kent, Ohio. The first hypothesis was that there are changes in dietary intake between different phases of the normal menstrual cycle. The second hypothesis was women experience food cravings during the menstrual cycle. The study results indicated there are no significant differences between the three phases in energy and macronutrient consumption (P >0.05); therefore, the research hypothesis was rejected. On the other hand, food craving episodes did exist throughout the menstrual cycle; therefore the second hypothesis was accepted.

Dietary Intake During the Menstrual Cycle

Previous studies suggested that food intake (energy and macronutrients) was significantly different between the three phases of the cycle. It was found that the luteal phase, which occur with the ovulation stage until the beginning of menstruation, this phase characterized by major increase in dietary intake. It was found to be associated with significantly high fat intake compared with the follicular phase (Johnson et al., 1994; Tarasuk & Beaton, 1991). In addition, this phase was characterized by high levels of carbohydrates in relation to the other phases (Dalvit-McPhillips, 1983), and it was found to be higher in energy (Kcal) intake (Lissner et al., 1988; Gong, Garrel & Calloway, 1989; Hill & Heaton-Brown, 1994). In contrary, the results from this study show no significant difference in energy and macronutrient intake during three phases of
the menstrual cycle (P <0.05). Although the result of the study did not show significant differences in craving between the luteal phase and the other two phases, the craving screening test that was completed by the participants with each food record, indicated participants were less relaxed (P ≤0.001) during the luteal phase (M=44.94, SD= 24.63) when compared with the follicular phase (M= 57.76, SD=23. 29). One of the major findings in this study was the percentage of energy and macronutrients intake. Although the selected participants showed normal scores in the initial eating disorder test during the pre assessment phase, after analyzing the food records and calculating the percentage of the recommended intake, it was found that these participants were consuming less than the recommended intake of energy, carbohydrates and fat.

**Food Craving During the Menstrual Cycle**

Previous studies found that food craving was related to the menstrual cycle, and it was found to occur in 74.3 percent of 5549 women (Dye, Warner & Bancroft, 1995). When the causes of food craving were investigated in women, it was suggested that the process of food craving is a response from the women’s body to the increased level of energy expenditure or to dietary deficiency. Also, it is considered to be a result of hormonal fluctuation during the menstrual cycle, or a response to negative emotions and stress (Yen et al., 2010). The food craving results for the present study supported the second hypothesis which indicated that food craving exists during the menstrual cycle in normal menstruating women. In contrary to studies that suggested craving was higher during the luteal phase by approximately 67 percent when compared to the menstrual and follicular phase (Hill & Heaton-Brown, 1994; Hormes & Timko, 2011), the current study
findings suggested that food craving existed throughout the cycle, during the three phases, and was not significantly related to specific phase. The total craving records (n=63) were completed by the 18 participants during the two months cycle (23 records during menstrual phase, 19 during the follicular phase, and 21 during the luteal phase), which resulted in food craving episode that existed at any phase of the cycle and sometime more than one phase per cycle.

**Dietary Restriction During the Menstrual Cycle**

In current study, many factors that may influence the dietary intake of our participants were controlled, such as medications, sport, weight status, eating disorder test, premenstrual syndrome test. However, it was found that participants who scored normal in all the pre-assessment tests, and after measuring their diet intake across the menstrual cycle, the caloric intake was lower than their recommended daily value. The average caloric intake of participants in all the three phases was 65 percent of the recommended caloric intake. These participants looked healthy and normal and did not show signs of eating disorder when tested using the EAT-26, however, food craving was prevalent across the cycle. While some participants did consume the craved food, some of them showed restrictive diet behavior, especially when they were asked (what did they do instead of not consuming the craved food item), some answers were as following:

“Continue shopping, kept driving, go to sleep, did nothing, stopped thinking about it while walking, closed my eyes and stopped thinking about it, chewed gum and drank water, ate a snack instead (Greek yogurt instead of pasta), plan to eat it tomorrow, just drank water, walk around and ate something different”
Restricting the regular diet and avoid eating the craved item or simply force oneself to stop thinking about the food may explain why there was no significant difference in energy and macronutrient intake between the three phases of the cycle. One of the questions in the food record was asking the participants (how much they did you try to restrict the craved food in the past), the average rates for restricting the craved food were 55.83 percent during the luteal phase, 37.18 percent during the follicular phase, and 48.83 percent during the menstrual phase. It was suggested that people who chronically restrict their diet are more susceptible to food craving and experience low self-control when they are exposed to the craved food item (Polivy, Coleman, & Herman, 2005). Another study also found that food craving was strongly associated with diet restriction (Massey & Hill, 2012).

Dietary restriction was considered to be one of the risk factors for food craving (Pelchat, 1997). Restricting specific nutrients was suggested to be related to change people’s behavior toward this nutrient, this may lead to food craving and binging (Coelho, Polivy & Herman, 2006). People who restrict carbohydrate intake found to be more susceptible to carbohydrate craving when compared with nonrestrictive eaters (Coelho, Polivy & Herman, 2006). Another study found that when people restrict their favorite foods, they tend to have more craving episodes comparing when they restrict regular food item (Polivy, Coleman & Herman, 2005). In addition, when restrained eaters were exposed to the food cues (smell and taste) of some of the restricted food items, they found that the restricted eater have more tendency to crave and react to the restricted food item (Fedoroff, Polivy & Peter Herman, 2003).
The definition of food restriction is not clear. Some studies classify participants as restrictor if they reported that they were dieting or controlling their food intake, or if they were restricted by the investigator. In many studies, investigator is the one who decided which food to avoid and which not. They give the subjects guidelines of what to restrict and then they expose them to the specific food item (e.g. chocolate) (Polivy, Coleman & Herman, 2005) or food category (e.g. high complex carbohydrate) and they measure participants’ reaction toward the tested/restricted food. Other studies they use some scales to measure dietary behavior such as the Revised Restraint Scale (Fedoroff, Polivy & Peter Herman, 2003) in order to categorize the participants to restraint and non-restraint groups.

In many studies, participants were exposed to the tested food in order to measure their reaction or level/intensity of craving episode. In this study, one question in the Food Craving Record was asked to know what stimulates their craving for specific foods. Data from 53 completed Food Craving Record throughout the cycle shows that 85% of the cases (n=45) they reported they were “simply thinking about the craved food”. More craving existed without even being exposed to food cues like smelling or seeing or tasting the craved food item.

Women participated in this study had normal BMI, normal EAT-26 score, and not on a diet. These women experienced food craving at least once per cycle. They were restricting their carbohydrate, fat and total calories, and thinking about the craved food item and sometimes trying to avoid eating it and to stop thinking about food. This raises the concern if they were self-depriving themselves or they were experiencing eating
behavior problems that were not detected by all the screening measures we used at the beginning of the study.

In conclusion, despite what was discovered by most previous research about food intake and menstrual cycle, this study failed to prove that food intake differs during the three phases of the normal menstrual cycle. In the other hand, it proofs that food craving is common among women during the reproductive age, and it exists throughout the normal menstrual cycle.

**Application**

When dietitians assess women during reproductive age (18-40 years), it is important to take into account that during this age period, women are predisposed to many hormonal and psychological changes as a result of their monthly menstrual cycle. This will impact their food intake and appetite. As a result, food craving and dietary intake fluctuations may happen at varying levels. Menstrual cravers were characterized by having more weight fluctuation, more guilt associated with their craving, and more dietary restriction (Hormes & Timko, 2011).

The main finding in this study was that all women experienced food craving, and all women were restricting their diet. The women participating in this study were subconsciously restricting their diet, as when they were asked at the initial stage (pre-assessment) if they were following weight controlled diet, they answered “No”. Food restriction is known to be associated with food craving (Coelho, Polivy & Herman, 2006; Polivy, Coleman & Herman, 2005; Fedoroff, Polivy & Peter Herman, 2003). There are many psychological consequences associated with food restriction, therefore, may
interfere with the intensity and frequency of food craving episodes. Studies found that food restriction whether it was intentional or non-intentional, it will lead to many emotional and cognitive problems that will affect the stability of diet and therefore weight and general health (Polivy, 1996). Self-restriction was lead participants to be preoccupied with weight and food, also increase food binging (Polivy, 1996).

Using standard measurement techniques may not be applicable for all women. There are different measurement scales to determine whether the participants were restricting their regular diet or not, however, our finding indicate that looking in depth at the actual intake for many days and analyzing each food item will reflect the actual consumption and whether it meets the recommended intake or not. Looking at women’s health status from many angels is crucial; they may have the perfect weight while they follow unhealthy procedures to maintain this weight such as self-restricting their diet.

When counseling a woman with initial signs of eating disorder or for diet restraining, it is essential to search for the causes of this condition, by treating the causes this will help to avoid further complication. Women need to take a part in analyzing their situation and also in setting the goals that help them to overcome the problem. Dietitian can use the cognitive behavior therapy (CBT) approach, also depending on the severity of the case and the symptoms, an enhanced cognitive behavior therapy could be used (CPT-E) if any of the following symptoms was a leading cause for the problem: clinical perfectionism, low self-esteem, and interpersonal problems (Murphy, Straebler, Cooper & Fairburn, 2010).
It is essential when dietitians need to give advice to the public regarding healthy eating, not to focus mainly on eating less or decreasing the calories and fat. This message may not be applied to all women. Because eating disorder and unhealthy eating practices are common among women and continuously increasing, the dietitian message need to take a holistic approach to promoting healthy eating, taking into account the importance of accepting different body sizes and shapes for women and the importance of enjoying the food. Promoting the caloric restricted diet as the ideal diet for all women during all the stages in their life is not acceptable, and may have negative consequences on the community if everyone perceived the restricted caloric diet as the perfect image of healthy life style.

Approximately 75 percent of the women participated in this study (n=46) experienced food cravings in the past. The current sample population of normally menstruating women showed that food craving exists in all phases of the menstrual cycle, and it could occur more than once per cycle. Experiencing many food carving episodes was associated with a high level of anxiety and negative mood (Hill, Weaver & Blundell, 1991). When counseling women that have multiple food cravings that negatively affect her psychological status and weight, dietitian need to look at the whole picture and see when and where and under what circumstances these cravings occurs. Knowing the craving triggers will help to solve the problem. It is essential to use the “Intuitive Eating” approach when dealing with women, especially when food cravings are the result of food restrain or even when the cravings are associated with feelings of guilt and emotional distress. Women need to learn to listen to their body and acknowledge the hunger and
satiety cues. Intuitive eating is defined as “responding to the internal physiological hunger and satiety cues coupled with a low preoccupation with food” (Avalos & Tylka, 2006). Unlike the feeling of hunger which results from psychological demand for food due to low calorie intake (Pelchat, 2002), craving for certain food is mainly results from psychological purpose to relief intense desire for that food in addition to stress or tension (Rabinovitz, 2005). However, in this study, women experienced food craving had also significant difference of the hunger levels pre and post the craving episode with low hunger level after consuming the craved food, this may raise the question whether the craved food, which mainly was high in fat and carbohydrate, are substituting healthy and nutritious food choices, and whether this may lead to binge eating and cause eating disorder issues. Women who intuitively eat their food are responding to their body and reacting to the hunger signals by eating the food and not delaying or ignoring it which lead to trust the body and being less preoccupied with food (Avalos & Tylka, 2006). Stopping craving or removing the craved item suddenly from women diet is not recommended. Gradual change is suggested and cooperating with the women to formulate their own plan and goals is necessary. It is essential to make the body adapt to a balanced diet routine every day in order to decrease the sudden and multiple craving episodes and regulate the hunger and satiety cues. If the food craving was a result of emotional distress, the dietitian should teach the women techniques to relieve the stress, such as doing favorable exercise or yoga or take a walk, instead of using the food as a way to relive the stress. If the craving was occasional, women need to learn how to enjoy the food and listen to their body. However, if the craving was persistent, dietitian need to
analyze the type and amount the craved food item and to give suggestions for healthier choices if the craved food was to affect the women's health.

The social media is considered one of the main resources that influence the public decision regarding to what and where should they eat and what is considered healthy and what is not, dietitians need to use this tool to increase the awareness about healthy eating, in addition they need to educate the women of where to get their daily eating tips and the importance of only use credible resources. They can use the social media as a resource to spread the idea of intuitive eating and accepting women with different shapes and sizes, opposing what is commonly seen image in the media as all women need to be in a standard shape and size. On the other hand, women need to know that not everything promoted in the media as the healthy way of living and the best diet, not everything fits to every woman. Balanced diet is essential; each woman should know what is best for her health and her age.

The consequences of food craving and diet restriction may not appear in the short term period. However, there are many known physiological and psychological problems linked to food craving, including eating disorder and emotional pressure, this will lead to failing to control weight and therefore affect total health and wellness. The main goal is to maintain the health and well-being for women and to enjoy the food in a balance way.

**Limitations**

The current study was limited by the use of a convenience sample. The sample population size may be a limitation as well because out of the 60 women who participated in the preassessment phase, only 18 were qualified to participate.
**Strengths**

One of the strengths was the length of the study as each woman was measured for two months to confirm that they have regular cycles. The menstrual cycle was tracked daily and the food intake and craving were measured in each phase. In addition, using tight inclusion criteria, as weight and each woman screened for eating disorder, premenstrual syndrome and confirming the normal menstrual cycle.

**Conclusion**

In summary, the result of the current study did not find significant differences in dietary intake, energy and macronutrients (carbohydrate, protein, and fat), during the three phases of the normal menstrual cycle. The food records show that the participants all had a low dietary intake. Total calorie, fat and carbohydrate intake was lower than the recommended intake, with mean energy intake of 1569 Kcal (65.05 percent of the recommended intake), 208.16 g of carbohydrate (63.19 percent of the recommended intake), and 64.53 g of fat (71.74 percent of the recommended intake).

On the other hand, the second hypothesis was accepted as the food cravings results from the present study indicated that food craving exists during menstrual cycle in normal menstruating women. In contrary to studies that suggested craving was higher during the luteal phase (Hill & Heaton-Brown, 1994; Hormes & Timko, 2011), the current study findings suggested that food craving existed throughout the cycle, during the three phases, and was not significantly related to specific phase. The total craving records (n=63) were completed by the 18 participants during the two months cycle (23 records during menstrual phase, 19 during the follicular phase, and 21 during the luteal
phase), which resulted in food craving episode that existed at any phase of the cycle and sometime more than one phase per cycle. Data from 53 completed Food Craving Record throughout the cycle shows that 85 percent of the cases (n=45) they reported they were “simply thinking about the craved food”. More craving existed without even being exposed to food cues like smelling or seeing or tasting the craved food item.

Further studies are needed to examine the dietary behaviors of women during different phases of the cycle. The intensity of food craving in each phase needs to be measured. The type of the craved foods needs to be analyzed and measured in correlation with the severity of food restriction. Women during reproductive age need to be categorized for different age group and the eating behavior and dietary restriction in each group need to be tested in depth. In addition, the effect of using the intuitive eating approach and other techniques to increase the awareness about food and body need to be measured in each group in correlation with menstrual cycle changes.
APPENDICES
APPENDIX A

CONSENT FORM
Appendix A

Consent Form

Dietary Changes and Food Craving During Normal Menstrual Cycling
IRB# 13-521

Introduction
This study attempts to collect information about dietary intake and food cravings during menstrual cycle.

Procedures
In order to determine your eligibility for participating in this study, you will be asked to complete four questionnaire surveys. First is the Health history questionnaire which asks general health questions such as age and weight, and other questions about the menstrual cycle. Second is the EAT-26 questionnaire which measures the eating behavior. Third is the Mental and Physical Symptom Daily Rating Scale which measures several symptoms that you may experience before the menstruation phase. Lastly, is a Food Craving questionnaire that measures your past food craving experience. Please note that these surveys are used for screening and determining the qualified participants to continue for the next part of the study. The average time of participating in this part of the study will take no longer than 20 minutes. This questionnaire will be conducted with an on-line Quartics-created survey.

Eligible participants will proceed to the assessment stage. Several measurement methods and will last for two months (i.e. two menstrual cycles). Participants are expected to complete daily menstrual track record, 18 food records during all phases of the menstrual cycle in which they are expected to record all the food they eat during those days, Craving record that measures the craving experience only when they crave specific food. Finally, the ovulation phase will be measured by using (LH) urine test, minimum one and maximum 10 tests will be used per month depending on the ovulation results.

Negative result of the ovulation test or if you choose not to record the ovulation test result, this will result in withdrawal from the study.

Risks/Discomforts
Discomfort may occur as the study requires precise tracking of the menstrual cycle and completing the daily menstrual record. In addition, the food records are required to be filled during specific days distributed throughout the cycle.
Confidentiality
Participants need to report their names and contact information either phone number, email, or both. These information will help the investigator to contact each participant and meet with them during the assessment stage of the study in order to give them the surveys and give instructions during each phase of the cycle. In addition, the investigator will send reminders (text message and email) to remind each participant about the days they need to fill their surveys and food records.

All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be cancelled, and no one other than ten primary investigator and assistant researches listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigator.

Compensation
upon completing the study, nine participants will be drawn randomly to receive a cash payment ($20). All participants who pass the screening (pre-assessment) phase and proceed to the assessment phase will be included in the compensation drawing whether they continue the assessment phase or not.

Participation
Participation in this research study is completely voluntary. You have the right to withdraw at any time or refuse to participate entirely. If you desire to withdraw, please close your Internet browser and notify the investigator at this email: (aalbesh1@kent.edu). Or, if you prefer, inform the principal investigator as you leave.

Questions about the Research
If you have questions regarding this study, you may contact the principal investigator: Dr. Natalie Caine-Bish at 330-672-2148 (ncaine@kent.edu), or the co-investigator Amal K.Albeshri at 267-894-8592 (aalbesh1@kent.edu)

Questions about Your Rights as Research Participants
If you have questions you do not feel comfortable asking the researcher, you may contact the research supervisor, principal investigator: Dr. Natalie Caine-Bish at 330-672-2148 (ncaine@kent.edu) or the Kent State University Institutional Review Board, at (330) 672-2704.
Please type your name (First, Last)

________________________

I have read, understood, and printed a copy of, the above consent form and desire of my own free will to participate in this study.

• ☐ Yes
• ☐ No
APPENDIX B

HEALTH HISTORY QUESTIONNAIRE
Appendix B

Health History Questionnaire

First name
Last name
Email
Mobile number
Weight (lb)
Height (in)
Gender
  ○ Male
  ○ Female
Age category
  ○ 18 - 20
  ○ 21-30
  ○ 31-40
  ○ above 40
Last day of menses
  ○ one week ago
  ○ two weeks ago
  ○ three weeks ago
  ○ Four weeks ago
  ○ More than a month
Do you have normal menstrual cycle?
  ○ Yes
  ○ No
How many days your menses lasts
  1-4 days  4-7 days  7-10 days  Varies
How many days do you expect between two menstrual cycle
  20 24 days  25-29 days  30-35 days  36-40 days  Varies
Do you exercise?
  o Yes
  o No

If yes, type how many minutes per week

Do you participate in specific sport that requires regular training
  o Yes
  o No

If yes, specify type of sport

Do you use ANY of the following HORMONAL contraceptives (Combined oral contraceptive pills, Progestin-only pills, Contraceptive patch, Injectable birth control, vaginal rings, Implantable rods, Emergency Contraceptive Pills?)
  o Yes
  o No

Do you plan to get pregnant in the next two months?
  o Yes
  o No

Do you take any medications that affect your appetite?
  o Yes
  o No

Do you take any medications that affect your menstrual cycle?
  o Yes
  o No

Do you have any medical disorders that affect your appetite
  o Yes
  o No

Do you have any medical problem that affects your menstrual cycle?
  o Yes
  o No
APPENDIX C

EATING ATTITUDE TEST -26 (EAT-26)
Appendix C

Eating Attitude Test -26 (EAT-26)

Part A

<table>
<thead>
<tr>
<th>Part B: Check a response for each of the following statements:</th>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Some times</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Am terrified about being overweight.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>2. Avoid eating when I am hungry.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>3. Find myself preoccupied with food.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>4. Have gone on eating binges where I feel that I may not be able to stop.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>5. Cut my food into small pieces.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>6. Aware of the calorie content of foods that I eat.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>7. Particularly avoid food with a high carbohydrate content (i.e., bread, rice, potatoes, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>8. Feel that others would prefer if I ate more.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>9. Vomit after I have eaten.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>10. Feel extremely guilty after eating.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>11. Am preoccupied with a desire to be thinner.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>12. Think about burning up calories when I exercise.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>13. Other people think that I am too thin.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>14. Am preoccupied with the thought of having fat on my body.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>15. Take longer than others to eat my meals.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>16. Avoid foods with sugar in them.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>17. Eat diet foods.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>18. Feel that food controls my life.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>19. Display self-control around food.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>20. Feel that others pressure me to eat.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>21. Give too much time and thought to food.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>22. Feel uncomfortable after eating sweets.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>23. Engage in dieting behavior.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>24. Like my stomach to be empty.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>25. Have the impulse to vomit after meals.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part C: Behavioral Questions:</th>
<th>Never</th>
<th>Once a month or less</th>
<th>2-3 times a month</th>
<th>Once a week</th>
<th>2-6 times a week</th>
<th>Once a day or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the past 6 months have you:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Gone on eating binges where you feel that you may not be able to stop?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>B. Ever made yourself sick (vomited) to control your weight or shape?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>C. Ever used laxatives, diet pills or diuretics (water pills) to control your weight or shape?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>D. Exercised more than 60 minutes a day to lose or to control your weight?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>E. Lost 20 pounds or more in the past 6 months</td>
<td>Yes</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
</tbody>
</table>

Copyright: EAT-26 (Garner et al. 1982, Psychological Medicine, 12; 871-878); adapted by D. Garner with permission.

Source: EAT-26 (Garner et al. 1982, Psychological Medicine, 12; 871-878)
Thank you for your permission request to reproduce and use the EAT-26. The EAT-26 is protected under copyright; however, all fees and royalties have been waived because it has been our wish for others to have free access to the test.

Please consider this e-mail as granting you permission to reproduce the test for the purpose suggested in your request as long as the EAT-26 is cited properly. The correct citation is: "The EAT-26 has been reproduced with permission. Garner et al. (1982). The Eating Attitudes Test: Psychometric features and clinical correlates. Psychological Medicine, 12, 871-878."

You can download a copy of the scoring instructions and the test on the homepage of the EAT-26 website. If you use the written version of the test, it is recommended that you provide respondents with the link to the EAT-26 website (www.eat-26.com) so that they can learn more about the test.

Again, thank you for requesting permission to reproduce and use the EAT-26. If you intend on publishing your work, please send me your results so that they can be included in a research database being developed on the EAT-26 website (www.eat-26.com).

Best wishes,

David M. Garner, Ph.D.
Administrative Director
River Centre Clinic
5465 Main Street
Sylvania, OH 43560
dm.garner@gmail.com
APPENDIX D

THE MENTAL AND PHYSICAL SYMPTOMS DAILY RATING SCALE
Appendix D

The Mental And Physical Symptoms Daily Rating Scale

Part A

Please rate each of the following symptoms according to your experience before menstruation.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Not at all (0)</th>
<th>Slight (1)</th>
<th>Moderate (2)</th>
<th>Severe (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stay at home, avoid social activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Less work (job, house, school), impaired</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Mood swings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Depressed, sad, low, blue, lonely</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Anxious, jittery, nervous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Irritable, angry, impatient</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Appetite up, eat more, crave foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. More sleep, naps, stay in bed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Insomnia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Accident-prone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Suicidal thoughts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Low energy, tired, weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Feel bloated, have swelling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Constipated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Diarrhea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Back, joint, or muscle pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Abdominal pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Nauseated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Vomiting</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>20. Breast pain or discomfort or discharge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Headache</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Vaginal bleeding</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Part B

The Mental And Physical Symptoms Daily Rating Scale Permission
APPENDIX E

FOOD CRAVING HISTORY QUESTIONNAIRE
Appendix E.

Food Craving History Questionnaire

Food Craving History

PART A.

Please answer the following questions

Have you ever experienced food craving (i.e. an intense desire for specific food)
  o  Yes
  o  No

If Yes, please list the most three craved food
Please indicate how often do you experience that craving (times/month)

<table>
<thead>
<tr>
<th>Type of food</th>
<th>Times/month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

When you are experiencing a craving for certain food, is there any other food which would satisfy that craving?
  o  Yes
  o  No

If yes, Please explain


When you are experiencing food craving, how often you follow through and eat that food (% of the time)


How do you feel when you've eaten the food you craved the most

<table>
<thead>
<tr>
<th>Very satisfied</th>
<th>Satisfied</th>
<th>Somewhat Satisfied</th>
<th>Neutral</th>
<th>Somewhat Dissatisfied</th>
<th>Dissatisfied</th>
<th>Very Dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
</tbody>
</table>

☐

Do you feel that your cravings are related to your menstrual cycle

<table>
<thead>
<tr>
<th>Always</th>
<th>usually</th>
<th>often</th>
<th>sometimes</th>
<th>rarely</th>
<th>never</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Part B

Food Craving History Questionnaire Permission

Feel free to sue it. Good luck with your research.

Harvey P. Weingarten
President & CEO
Higher Education Quality Council of Ontario
1 Yonge St, Suite 2402
Toronto, ON M5E 1E5
416212.3821
hweingarten@heqco.ca

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APPENDIX F

THE MENSTRUAL CYCLE TRACKING RECORD
Appendix F

The Menstrual Cycle Tracking Record

**Menstrual Cycle Track Record (Menstrual Phase)**

- Please fill in the dates.
- Day 1 is the first day of menstruation.
- When you mark the last day of menstruation, this means you finished this phase, and the next day is the beginning of the (Follicular Phase. Please take the Follicular Phase folder and start tracking the rest of the cycle.
- Example: Day 1 (02-5-2014), Day 2 (02-6-2014)………Day 7 (02-11-2-14), Day 8 No Bleeding (This will be Day 1 in the Follicular Phase, go to the follicular phase folder and start recording).

<table>
<thead>
<tr>
<th>DATE</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
<th>Day 9</th>
<th>Day 10</th>
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<td>DATE</td>
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</table>

**Menstrual Cycle Track Record (Follicular Phase)**

- Please fill in the dates.
- Day 1 is the first day of Follicular Phase (the day after menstruation ends).
- Use the ovulation test during this phase.
- When the result of the ovulation test = positive (this is the end of the follicular phase, start in the Luteal Phase folder).

<table>
<thead>
<tr>
<th>DATE</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
<th>Day 9</th>
<th>Day 10</th>
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</tbody>
</table>
Menstrual Cycle Track Record (Luteal Phase)

- Please fill in the dates.
- Day 1 is the first day of Luteal Phase (the beginning of OVULATION)
- This phase ends when you start your menstruation
- The beginning of the menstruation is the end of this Luteal Phase and the beginning of the Menstrual Phase

<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
<th>Day 9</th>
<th>Day 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td></td>
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</tr>
</tbody>
</table>
Appendix G

Food Record

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal/ Snack</th>
<th>Food Item</th>
<th>Ingredients</th>
<th>Amount</th>
<th>How Prepared</th>
<th>Brand Name</th>
<th>Food Label</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
APPENDIX H

FOOD CRAVING RECORD
Appendix H

Food Craving Record

Part A

CRAVING RECORD

Date………………/ Phase………………

Please complete a new record every time you have a food craving, regardless of whether or not you eat.

1-Where were you when the craving began?
   o At home
   o At work
   o Other. Specify………..

2-Were you ……
   o Alone
   o In company

3-What time did the craving begin…………

4-Immediately before the craving did you? (check any that apply)
   o See or smell the food craved
   o See or smell other food
   o Simply think about the food craved
   o Simply think about other food
   o Eat the food craved
   o Eat other food

5. Rate how you felt immediately before the craving

<table>
<thead>
<tr>
<th></th>
<th>0=Not at all</th>
<th>1=slightly</th>
<th>2=Moderately</th>
<th>3=Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>Dissatisfied</td>
<td>Relaxed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alert</td>
<td>Nervous</td>
<td>Sluggish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sad</td>
<td>Calm</td>
<td>Tired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energetic</td>
<td>Tense</td>
<td>Contented</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. How hungry were you immediately before the craving?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Hungry</th>
<th>Extremely Hungry</th>
</tr>
</thead>
</table>

119
7. How strong was the craving?
- Not at all
- Strong

8. How difficult was the craving to resist?
- Not at all
- Difficult

9. What exactly was the craving for?
- ..........................................
- ..........................................
- ..........................................

10. Recently, how much have you tried to restrict eating this food?
- Not at all
- A lot

11. Did you eat as a result of the craving?
   - Yes
   - No

12. If “NO”, what did you do instead? .................................................................

13. If “YES”, describe in detail what you ate
   - ..........................................
   - ..........................................
   - ..........................................
   - ..........................................

14. If “YES”, how long did you resist the craving? .............minutes

15. If “YES”, how pleasant was the taste of what you ate?
- Not at all
- Extremely pleasant

16. Having experienced the craving, how quickly did it disappear?
- Not at all
- Extremely Quickly

17. How hungry were you after the craving?
- Not at all
- Extremely Hungry
18. Rate how you felt after the craving

<table>
<thead>
<tr>
<th></th>
<th>0=Not at all</th>
<th>1=Slightly</th>
<th>2=Moderately</th>
<th>3=Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>Dissatisfied</td>
<td>Relaxed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alert</td>
<td>Nervous</td>
<td>Sluggish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sad</td>
<td>Calm</td>
<td>Tired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energetic</td>
<td>Tense</td>
<td>Contented</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hi Amal

You are most welcome to use the craving record. I've attached a slightly updated version and a recent paper describing its use. Hope you find it useful.

Best wishes

Andrew

Andrew J Hill, PhD CPsychol
Professor of Medical Psychology
Head of the Academic Unit of Psychiatry & Behavioural Sciences
Director of Student Progression

Institute of Health Sciences
Leeds University School of Medicine
101 Clarendon Road
Leeds LS2 9LU

Tel: 0113 343 2734

http://www.leeds.ac.uk/hsptr/people/a-hill.html
APPENDIX I

THE FLOW OF THE 3 PHASES OF THE CYCLE
(OVERVIEW OF THE ASSESSMENT PHASE PROCESS)
Appendix I

The Flow Of The 3 Phases Of The Cycle
(Overview Of The Assessment Phase Process)
APPENDIX J

KSU IRB PERMISSION
Appendix J

KSU IRB Permission

IRB approval for protocol #13-521 - retain this email for your records

2 messages

Wed, Dec 4, 2013 at 12:30 PM

E: IRB # 13-521 entitled “Dietary changes and food craving during normal menstrual cycling”

Hello,

I am pleased to inform you that the Kent State University Institutional Review Board reviewed and approved your Application for Approval to Use Human Research Participants as a Level II/Expedited, category 4, 7 project. **Approval is effective for a twelve-month period:** December 3, 2013 through December 2 2014.

* A copy of the IRB approved consent form is attached to this email. This "stamped" copy is the consent form that you must use for your research participants. It is important for you to also keep an unstamped text copy (i.e., Microsoft Word version) of your consent form for subsequent submissions.

Federal regulations and Kent State University IRB policy require that research be reviewed at intervals appropriate to the degree of risk, but not less than once per year. The IRB has determined that this protocol requires an annual review and progress report. The IRB tries to send you annual review reminder notice to by email as a courtesy. **However, please note that it is the responsibility of the principal investigator to be aware of the study expiration date and submit the required materials.** Please submit review materials (annual review form and copy of current consent form) one month prior to the expiration date.

HHS regulations and Kent State University Institutional Review Board guidelines require that any changes in research methodology, protocol design, or principal investigator have the prior approval of the IRB before implementation and continuation of the protocol. The IRB must also be informed of any adverse events associated with the study. The IRB further requests a final report at the conclusion of the study.

Kent State University has a Federal Wide Assurance on file with the Office for Human Research Protections (OHRP); **FWA Number 00001853.**
If you have any questions or concerns, please contact the Office of Research Compliance at Researchcompliance@kent.edu or 330-672-2704 or 330-672-8058.

Respectfully,
Kent State University Office of Research Compliance
224 Cartwright Hall | fax 330.672.2658
Kevin McCreary | Research Compliance Coordinator | 330.672.8058 | kmccrea1@kent.edu
Paulette Washko | Manager, Research Compliance | 330.672.2704 | Pwashko@kent.edu
REFERENCES


http://journals.cambridge.org/download.php?file=%2FBJN%2FBJN61_02%2FS007114589000279a.pdf&code=f64e0a5c63dc106614e1b68b258da7cd

http://ajcn.nutrition.org/content/61/1/39.full.pdf


http://aje.oxfordjournals.org/content/152/5/446.full.pdf+html


Garner et al. (1982). The Eating Attitudes Test: Psychometric features and clinical correlates. Psychological Medicine, 12, 871-878

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Waters, A., Hill, A., & Waller, G. (2001). Bulimics' responses to food cravings: is binge-eating a product of hunger or emotional state?. Behaviour Research and Therapy, 39(8), 877-886. DOI: 10.1016/S0005-7967(00)00059-0


