

Running head: DYSMENORRHEA AND BMI

Dysmenorrhea and Body Mass Index

by

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Abstract

Dysmenorrhea is a common gynecological complaint among women, one that costs the U.S. economy approximately \$2 billion in lost productivity each year. The present observational study examined the correlation of BMI and diagnoses of dysmenorrhea in a large sample of women ages 18-40 seen in an outpatient setting over the course of one year at a large health system in southeast Michigan. Although there were no statistically significant differences in the probability of dysmenorrhea among women of different BMI groups, the trending information seemed to suggest that dysmenorrhea is not influenced by BMI categories per se, but by extremes in body weight. Future research must include a larger data set so that differences between BMI groups can be more readily detected. It may also be prudent to control for nulliparity in future studies since dysmenorrhea has been shown to be inversely related to parity.

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Chapter 1: Introduction and Background

Introduction

Dysmenorrhea, or painful menstrual cramps, is a common gynecological complaint among women of childbearing age. In the United States, it is the leading cause of school-related absences for adolescent girls (Tran, Odle, & Frey, 2011) and accounts for approximately 600 million hours of lost work productivity in adult women every year, which results in an economic loss of about \$2 billion annually (Dawood, 1984; Coco, 1999). Symptoms of dysmenorrhea include pelvic and/or abdominal pain that is experienced in any number of ways, including throbbing, shooting, stabbing, burning, and/or nauseating. The pain may also spread into the lower back and down the thighs (Tran et al., 2011). In addition to pain, women may also have other symptoms, such as nausea; vomiting; sweating; headaches; diarrhea (Ju, Jones, & Mishra, 2013); constipation; hypersensitivity to lights, sounds, or odors; general irritability; fatigue; and dizziness (Tran et al., 2011). While many women have normal cramping in the days leading up to and during their menstrual cycles, dysmenorrhea is different in that it is disruptive enough “as to limit the woman’s normal activities or require medical or surgical treatment” (Tran et al., 2011, p. 1430).

Dysmenorrhea is characterized as either primary or secondary. Primary dysmenorrhea is defined as pain in the absence of a specific abnormality (Tran, Odle, & Frey, 2011), and almost always presents initially in women under the age of 20 (Ju, Jones, & Mishra, 2013). There are several theories as to the underlying cause of primary dysmenorrhea; however, the current leading explanation is an overproduction of hormone-like substances called prostaglandins which triggers intense muscle contractions in the uterus immediately before and during menstruation (Tran et al., 2011). Secondary dysmenorrhea, on the other hand, is diagnosed when the pain can

be attributed to a specific underlying condition or disease, such as endometriosis, fibroids, cysts, an untreated pelvic infection, or an ectopic pregnancy (Tran et al., 2011), and tends to affect women over the age of 20 (Ju et al., 2013).

Estimated Prevalence Rates

While anecdotal evidence clearly shows that dysmenorrhea is a pervasive problem among women in both developed and developing countries, hard data on prevalence rates are highly variable, ranging from as low as 5-20% in one systematic review looking at adult women in developing countries who reported pain severe enough to limit their normal daily activities (Harlow & Campbell, 2004) up to as high as 93% in an Australian study looking at teenagers who reported any degree of menstrual pain (Parker, Sneddon, & Arbon, 2009). Such wide variability is due an assortment of factors, namely non-standardization of what constitutes dysmenorrhea (e.g., reports of any pain at one extreme to reports of severe, life-disruptive pain at the other extreme); a failure to distinguish between primary and secondary dysmenorrhea; differences in how the data are collected (e.g., self-reporting, daily diary, or interview); differences in the duration of data collection (e.g., one month versus 12 months; Ju, Jones, & Mishra, 2013); and the use of many different assessment tools, some of which are geared specifically toward menstrual pain while others are more generic (e.g., studies have used the Moos Menstrual Distress Questionnaire, the Andersch and Milsom classification, the World Health Organization Quality of Life-BREF questionnaire, and the McGill Pain Questionnaire, just to name a few; Zahradnik, Hanjalic-Beck, & Groth, 2009). Not only is there a considerable lack of standardization and uniformity, “the majority of [the literature on dysmenorrhea] provides only a snapshot view of the disorder from cross-sectional studies and suffers from

selection bias as they are based on convenience samples of mainly young college students” (Ju et al., 2013, p. 105).

Potential Risk Factors

Not only are prevalence rates hard to pin down, but the underlying causes of dysmenorrhea remain difficult to elucidate. All research points to a multi-factorial etiology in which a multitude of demographic, obstetric/gynecological, environmental, and /or psychological influences may be interacting in the development of dysmenorrhea (Latthe, Mignini, Gray, Hills, & Khan, 2006). In the *Gale Encyclopedia of Medicine*, Tran, Odle, and Frey (2011) provide a fairly comprehensive overview of the possible risk factors associated with dysmenorrhea, which include a family history of painful periods, high levels of stress, current tobacco use, nulliparity, age of less than 20, early puberty (before age 11), personal history of heavy periods, lack of exercise, excessive caffeine consumption, attempts to lose weight rapidly, a diagnosis of Pelvic Inflammatory Disease (PID), and personal history of sexual abuse.

While there is at least some evidence that the above risk factors may play a role in the development of dysmenorrhea, systematic reviews of the literature often show mixed or inconclusive results (Ju, Jones, & Mishra, 2013). A recent literature review conducted by Ju, Jones, and Mishra (2013) identified 3 longitudinal studies and 12 population-based, cross-sectional studies from which the authors tried to identify a more accurate representation of the prevalence, incidence and risk factors of dysmenorrhea world-wide. Like most reviews involving dysmenorrhea, this review took a narrative rather than a meta-analytic approach due to the “profound heterogeneity in study populations, definition of dysmenorrhea, and measurements of risk factors among the included studies” (Ju et al., 2013, p. 112). Once again, the inconsistent variables used in dysmenorrhea research do not allow much in the way of identifying

generalizable trends, and the Ju et al. literature review illustrates this point beautifully as many of the so-called risk factors were found to have mixed results. Of the 25+ risk factors examined, only family history of dysmenorrhea and higher stress levels were found to have a relatively consistent association with the reporting of painful periods; older age, an increased number of live births, and birth control use consistently revealed a protective effect against the development of dysmenorrhea (2013).

Statement of the Problem

Dysmenorrhea is an important women's health issue that deserves serious attention for a number of reasons. Not only is it a very common gynecological complaint that results in hundreds of millions of hours of missed school and work, it also costs the U.S. economy billions of dollars in lost productivity each year (Dawood, 1984; Coco, 1999). It has become socially normalized for women with dysmenorrhea to suffer in silence, assuming that their symptoms are a normal part of being a woman. Until the exact causes can be determined, treatments will continue to be inadequate, leaving women relatively powerless when it comes to this aspect of their gynecologic health.

Purpose of the Study

The present observational study seeks to tease out the role of weight in the development of dysmenorrhea, which is but one of many factors that has been examined in the literature with differing results. Some research has suggested that higher body mass index (BMI) and obesity contribute to the development of dysmenorrhea (Harlow & Park, 1996; Kaur, 2014), while other studies have failed to show such associations (Sundell, Milsom, & Andersch, 1990; Kritz-Silverstein, Wingard, & Garland, 1999; Maruf, Ezenwafor, Moroof, Adeniyi, & Okoye, 2013; Omidvar & Begum, 2012; Ju, Jones, & Mishra, 2013). Still others contend that women who are

underweight have a higher incidence of dysmenorrhea compared to their healthy-weight counterparts (Madhubala & Jyoti, 2013; Shah, Correia, Vitonis, & Missmer, 2013; Latthe, Mignini, Gray, Hills, & Khan, 2006). BMI was chosen not only because it is a modifiable risk factor, but also because popular media and healthcare providers point to excessive weight as an indisputable “cause” of dysmenorrhea. The present study examines a large cohort of adult women living in southeast Michigan both with and without dysmenorrhea, and seeks to determine if there is any correlation between a woman’s BMI and her likelihood of having dysmenorrhea.

Chapter 2: Literature Review

A review of the relevant literature on dysmenorrhea and BMI reveals four distinct perspectives on the issue: (1) being *overweight* increases the odds that a woman will develop dysmenorrhea, (2) being *underweight* increases the odds that a woman will develop dysmenorrhea, (3) there is no correlation between BMI and dysmenorrhea, and (4) there is simply not enough corroborating evidence to implicate the possible role of body weight in the development of dysmenorrhea.

Perspective 1: High BMI Contributes to Dysmenorrhea

A simple internet search with the phrase “severe menstrual cramps and body weight” yields a multitude of articles that state unequivocally that being overweight or obese increases the likelihood that a woman will experience painful menstrual cramps. WebMD, a very popular health information website, lists being overweight or obese as one of the “circumstances that may make a woman more likely to experience menstrual cramps” (p. 1, 2013). An article on a similar website states, “If you want to reduce those severe cramps every month, losing a few pounds might be the way to go” (Orfano, 2013). Yet another article found on PreventDisease.com claims that “women who are overweight have twice the risk for having severe and prolonged cramping as women who are not overweight” (p. 7, n.d.). Even large academic medical institutions, such as the University of Maryland Medical Centers, list “being either excessively overweight or underweight...” as a risk factor for developing the condition (p. 10, 2013). While electronic media sources are quick to associate body weight issues with dysmenorrhea, the literature supporting this stance is scant at best.

Harlow and Park (1996) recruited 165 women aged 17-19 who were starting their first year of college, and asked them to keep a one-year menstrual diary. Aside from weight, the researchers also looked at physical activity, various psychosocial stressors, and menstrual cycle

characteristics. Pain severity was recorded by the young women on a scale of 1, which represented minimal pain, to 5, which represented unbearable pain. After compiling the data and applying multiple logistic regression analysis, they concluded that “very heavy women [defined as being in the 90th percentile of weight-for-height] had about a 75% increase in their odds of having menstrual cramps” (p. 1138). They go on to say that “the odds of having multiple pain episodes were... nearly doubled in heavy women” (p. 1139) and “unusual pain patterns, in which pain increased during the bleeding episode rather than decreasing, were most common in heavy women” (p. 1139).

Kaur (2014) reached a similar conclusion after interviewing and assessing BMI and lipid profiles of 1400 teenagers and young women aged 17-22 at various educational institutions. Although not statistically significant, Kaur found a “slightly higher rate of obesity among girls with dysmenorrhea and unhealthy status of lipid profile among subjects reporting dysmenorrhea” (p. 222); however, he notes that obesity “may be one of the factors but not the culprit behind dysmenorrhea” (p. 214). Rather than oversimplifying the issue, Kaur notes that there are likely many factors contributing to dysmenorrhea, and that further research on environmental and biochemical levels will be necessary in order to reach any definitive conclusions.

Perspective 2: Low BMI Contributes to Dysmenorrhea

In stark contrast to the idea that high body mass index contributes to dysmenorrhea, some research has shown that the exact opposite is true: that low body mass index tends to predispose a woman to developing dysmenorrhea. Perhaps the most compelling evidence to support this position comes from a study conducted on 400 adolescent girls in India, 200 of whom lived in a rural setting and 200 of whom lived in a more urban setting. Not only were the rates of dysmenorrhea extremely high in both groups (81.5% rural and 76% urban), they found that

absolutely none of the girls with a normal BMI had symptoms of dysmenorrhea. In fact, it was the girls with a very low BMI who had the highest rates of painful menstrual cramps. In the rural setting, all girls who reported moderate or severe dysmenorrhea had a BMI of less than 16.5. In the urban setting, 80% of the girls with moderate dysmenorrhea had a BMI of less than 16.5, and all girls with severe dysmenorrhea had a BMI of less than 16.5 (Madhubala & Jyoti, 2013).

A systematic review conducted by British researchers looked at 29 studies related to dysmenorrhea and concluded that having a BMI of less than 20 was indeed a risk factor; however, upon closer inspection of the standardized mean difference (0.19) it appears that the effect was relatively small (Latthe, Mignini, Gray, Hills, & Khan, 2006).

Although the bulk of the present exploration has focused only on primary dysmenorrhea, it would be imprudent to exclude a recently published large-scale prospective cohort study examining data on 116,430 female nurses in the U.S. both with and without a diagnosis of endometriosis, which is a form of secondary dysmenorrhea. The researchers found that morbidly obese women (BMI > 40) had a 39% lower rate of endometriosis compared to the low-normal BMI reference group, and women with the smallest waist-to-hip ratio had a 3-fold increase in the rate of endometriosis (Shah, Correia, Vitonis, & Missmer, 2013). Furthermore, the researchers noted:

In the present study, it appears that the inverse association between current BMI and endometriosis is largely driven by a woman's BMI at age 18, suggesting that there is an etiologically relevant 'early window of exposure' during which higher body size reduces an individual's subsequent risk of developing endometriosis. (p. 1789)

Perspective 3: No Correlation between Body Weight and Dysmenorrhea

A third group of research also exists, in which absolutely no correlation between BMI and dysmenorrhea has been backed up by rigorous data collection and analysis. Researchers in Sweden interviewed several thousand women aged 19 who were living in Goteberg at the time, then followed-up with the same group of women 5 years later to assess prevalence rates over time as well as possible risk factors involved in dysmenorrhea. Among other findings unrelated to the present discussion, it was determined that neither height nor weight had any effect on the severity or prevalence of dysmenorrhea (Sundell, Milsom, & Andersch, 1990).

American researchers studying young women aboard U.S. Navy ships came to the same conclusion – namely, that BMI had no association with any sort of menstrual disorder, including dysmenorrhea specifically. They go on to acknowledge, however, that the population they chose to study was not necessarily representative of all women, as the group's BMI mean was only 23.6 and the mode was 22.4 (Kritz-Silverstein, Wingard, & Garland, 1999).

Similar research has been conducted in cross-sectional studies both in Africa and in India. African researchers studied a large group of 1383 adolescent girls with dysmenorrhea, but instead of using BMI the researchers examined adiposity as a measurement of waist circumference. Again, the data failed to show any correlation between the severity of their symptoms and their waist circumference, which is a good surrogate for BMI measures (Maruf, Ezenwafor, Moroof, Adeniyi, & Okoye, 2013). In India, a smaller yet comparable study was conducted on 500 young women aged 18-28 and found that “the distribution of women with and without dysmenorrhea into various BMI categories was not statistically significant at 5% level” (Omidvar & Begum, 2012, p. 9).

Perspective 4: Not Enough Information to Reach a Conclusion

Finally, researchers have conducted systematic reviews of the literature in an attempt to conclusively identify which factors may be protective and which factors may be detrimental when it comes to dysmenorrhea. As already mentioned in the above introduction, Ju, Jones and Mishra did just that (2013). They identified 15 primary studies and a previous systematic review in their analysis and found very mixed results. One longitudinal study found that being overweight was an important risk factor in term of experiencing menstrual pain (Harlow & Park, 1996), and one systematic review that found no association between dysmenorrhea and a woman's height and weight (Latthe, Mignini, Gray, Hills, & Khan, 1996). A pooled analysis of 5 other studies also indicated that there was no relationship between obesity and dysmenorrhea. The only definitive conclusions they were able to reach were that dysmenorrhea is inversely related to age, parity and the use of birth control pills, and it is positively associated with life stressors and a family history of dysmenorrhea. They go on to state that "uncertainty remains for a number of lifestyle factors, such as smoking, obesity and diet, psychological factors, and environmental factors" (p. 112).

As the relevant literature shows, there is still much to learn about the risk factors associated with dysmenorrhea, and BMI is clearly one such potential factor that deserves a more systematic assessment to determine its true role in the etiology and progression of the disease.

Chapter 3: Methodology

After obtaining proper permissions through IRBMED at the University of Michigan as well as Eastern Michigan University's College of Health and Human Services Human Subjects Review Committee (HSRC), a data report was obtained from the University of Michigan's Honest Broker Office that contained information regarding height, weight, BMI, and primary and secondary diagnostic data on unduplicated records from women between the ages of 18 and 40 who were seen in an outpatient setting within the University of Michigan Health System (UMHS) between December 1, 2012 and November 30, 2013. This particular date range was selected in order to assure that all visits would have ICD-9 diagnostic codes, as ICD-10 codes would be adopted by October 1, 2014 per the Department of Health and Human Services' ICD-10-CM federal implementation deadline, which has since been pushed back to October 1, 2015 (Administrative Simplification: Change to the Compliance Date for the International Classification of Diseases, 10th Revision (ICD-10-CM and ICD-10-PCS) Medical Data Code Sets, 2014). The new ICD-10 system is not simply an update to the older ICD-9 system. The new system was developed to allow healthcare providers more customization in their diagnostic coding based on disease specificity, severity and complexity. As a result the ICD-10 system will add a potential 54,000 new codes to the system (UMHS Revenue Cycle Compliance and Education, n.d.). Because the ICD-9 coding system is far simpler than the ICD-10 system, data extraction from electronic medical records based on ICD-9 codes is a more straightforward approach to data mining. Furthermore, the original data request was planned and submitted in late December 2013, which explains why the calendar year (1/1/2013-12/31/2013) was not used in the request.

Cohort Selection

The dysmenorrhea group included diagnosis codes for primary dysmenorrhea (ICD-9: 625.3) and all female pelvic pain (ICD-9: 625.9) diagnoses regardless of chronic status. Both cohorts were subjected to the same inclusion/exclusion criteria based on concomitant diagnoses, which are listed in Table 1.

Table 1

Cohort Inclusions and Exclusions

| Cohort Inclusions | Cohort Exclusions |
|---|--|
| <ul style="list-style-type: none"> • Any routine gynecological exam, health maintenance exam, annual physical exam, preventative healthcare exam, or well-woman exam • Encounter to establish care • Diagnoses related to routine sexually transmitted infection (STI) screening, unless also diagnosed with an STI • Routine cervical cancer and/or breast cancer screening • Contraception and family planning initiation, surveillance, advice, or education • Due or past-due immunizations • Any weight-related diagnoses (i.e., obesity, overweight, low weight) unless rapid and/or unexplained • Menstrual migraine and nausea/vomiting were also included, as these are common symptoms related to dysmenorrhea. | <ul style="list-style-type: none"> • Endometriosis • Polycystic Ovarian Syndrome (PCOS) • Fibroids • Cysts, ruptured or intact • Infertility, unless specifically associated with male factors • General abdominal pain • Positive pregnancy test • Postpartum status • Irregular or excessive bleeding • Amenorrhea • Any non-specific “screening” diagnosis code • STI screening with presence of known infection or pain symptoms • Known STI exposure • IUD removal without re-insertion of new IUD • Other diagnoses not based on routine health maintenance • Any record that did not include height, weight and BMI |

Working Data Set

The initial report contained information on 61,474 women. After incomplete data records were removed and appropriate exclusions applied (see Table 1), the final report consisted of 639 women with primary dysmenorrhea and 7,017 women who were seen for routine health maintenance purposes (i.e., the non-dysmenorrhea/reference group). BMI was broken down into 4 categories: underweight (15.1-18.5), normal/healthy (18.5-25.0), overweight (25.0-30.0), and obese (30.0-56.7). Age was broken down into 2 categories: younger women (ages 18-25), and older women (ages 26-40). Figures 1 through 3 show the distribution of women by age and by BMI group in both the dysmenorrhea cohort as well as the non-dysmenorrhea/reference cohort.

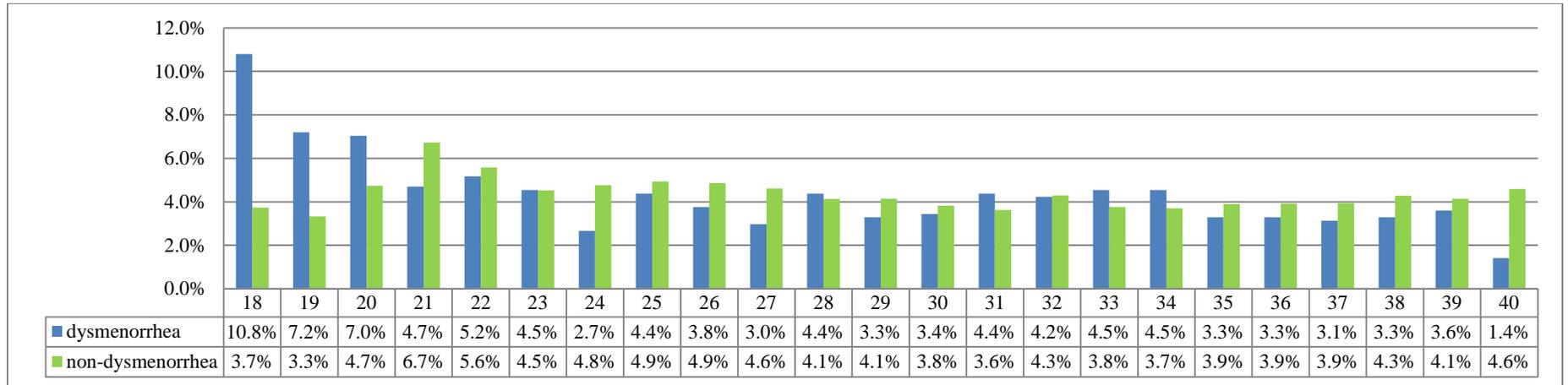


Figure 1. Distribution of Cohorts by Discrete Age.

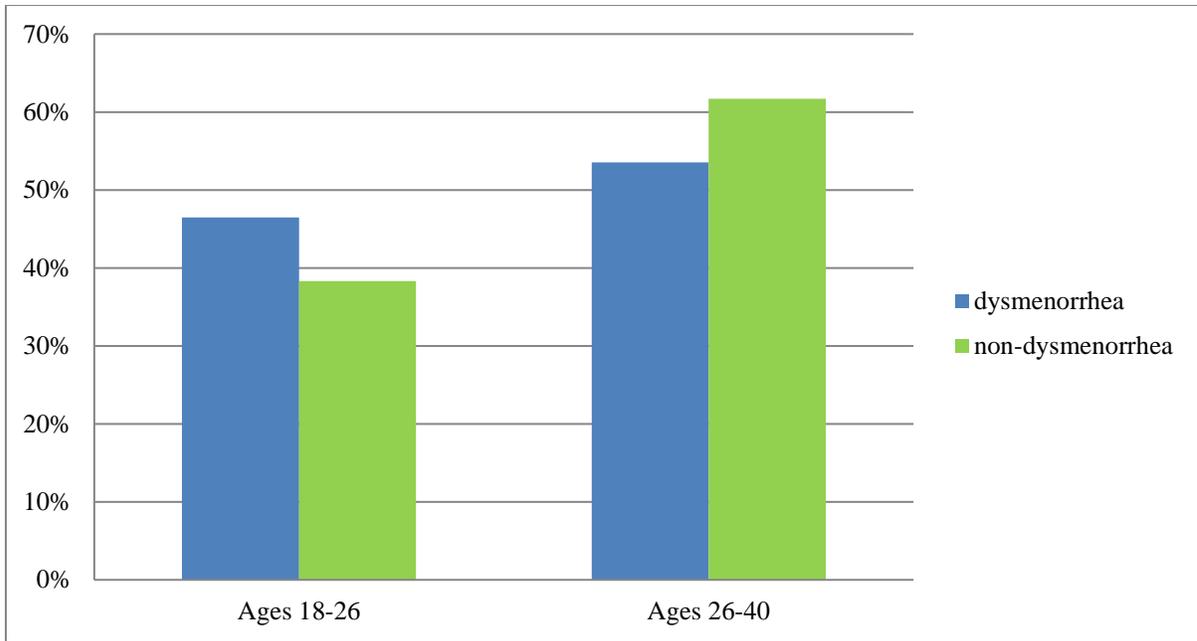


Figure 2. Distribution of Cohorts by Age Group.

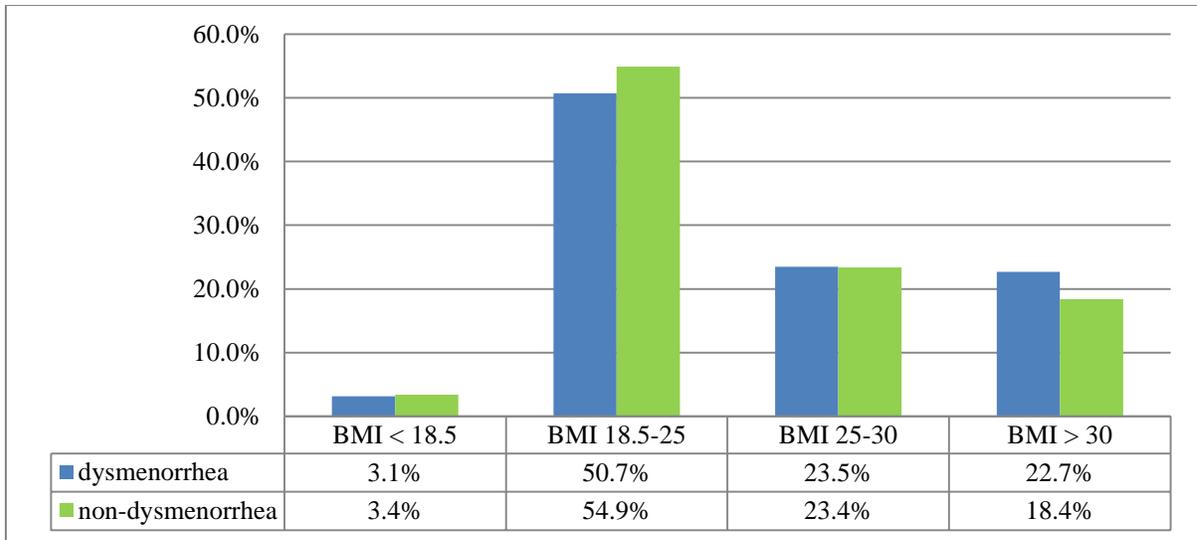


Figure 3. Distribution of Cohorts by BMI Group.

Chapter 4: Results

In the present observational study, the probabilities that certain groups of women experience dysmenorrhea were calculated to assess if there were differences between these groups. The dependent variable, dysmenorrhea, had only two possible outcomes: presence of dysmenorrhea or absence of dysmenorrhea. Logistic regression was used to model binary outcomes and calculate the probability of a success or failure, in this case the presence or absence of dysmenorrhea. The equation for the model is as follows: $\text{logit}(p) = \alpha + \beta x$ where $\text{logit}(p) = \log[p/(1-p)]$ and x is a certain independent variable. More than one independent variable may be added to the equation. The probability of success – in this case, the presence of dysmenorrhea – was obtained by solving the logistic regression equation for p (Faraway, 2006).

First, the differences in probability of experiencing dysmenorrhea for women of different BMI groups, regardless of age, were explored. The BMI groups were defined as follows: underweight ($\text{BMI} < 18.5$), normal ($18.5 < \text{BMI} < 25$), overweight ($25 < \text{BMI} < 30$), and obese ($\text{BMI} > 30$). Tables 2 and 3 show the estimates for the logistic regression model and probability of each BMI group of experiencing dysmenorrhea. As BMI increased, the probability of experiencing dysmenorrhea increased, however the p-values in the table indicate that these differences in probabilities were not significant.

Table 2

Estimates for the Logistic Regression Model by BMI Group

$$\text{logit}(p) = \alpha + \beta_{\text{normal}}X + \beta_{\text{overweight}}X + \beta_{\text{obese}}X$$

| Parameter | Estimate | Standard Error | z-value | Two-tailed p-value |
|------------------------------------|----------|----------------|---------|--------------------|
| Intercept (Underweight BMI, <18.5) | -2.4765 | 0.2328 | -10.637 | <0.001 |
| Normal BMI [18.5,25) | 0.0009 | 0.2399 | 0.004 | 0.997 |
| Overweight BMI [25,30) | 0.0853 | 0.2479 | 0.344 | 0.731 |
| Obese BMI >30 | 0.2924 | 0.2487 | 1.176 | 0.240 |

Table 3

Probability of Each BMI Group of Having Dysmenorrhea

The above estimates for the model shown in Table 2 give us the following probabilities.

| BMI Group | Probability of Dysmenorrhea |
|-------------|-----------------------------|
| Underweight | 0.07752213 |
| Normal | 0.07758651 |
| Overweight | 0.08384621 |
| Obese | 0.1011874 |

Next, the differences in probability of experiencing dysmenorrhea by age group, regardless of BMI, were explored. Tables 4 and 5 show the estimates for the logistic regression model and probabilities of experiencing dysmenorrhea for each group. The probability of experiencing dysmenorrhea was significantly larger for women in the younger age group (18 to 25) than for the older age group (26 to 40).

Table 4

Estimates for the Logistic Regression Model by Age Group

$$\text{logit}(p) = \alpha + \beta_{26\text{to}40\text{age.group}}X$$

| Parameter | Estimate | Standard Error | z-value | Two-tailed p-value |
|--------------------------------|----------|----------------|---------|--------------------|
| Intercept (18 to 25 age group) | -2.2028 | 0.06115 | -36.02 | <0.001 |
| 26 to 40 age group | -0.33546 | 0.08303 | -4.04 | <0.001 |

Table 5

Probability of Each Age Group of Having Dysmenorrhea

The above estimates for the model shown in Table 4 give us the following probabilities.

| Age Group | Probability of Dysmenorrhea |
|-----------|-----------------------------|
| 18 to 26 | 0.09950 |
| 26 to 40 | 0.073219 |

It is clear that there are differences in the probability of experiencing dysmenorrhea for women in different age groups. The next logical step in the analysis was to examine if there were differences in BMI groups within each of the age groups. Tables 6 through 9 show the logistic regression models and probability of experiencing dysmenorrhea for BMI groups within each age group. For the younger age group, the probability of experiencing dysmenorrhea was larger for the underweight and obese BMI groups, although the p-values indicated that none of these differences between groups were significant. For the 26 to 40 year age group, the probability of dysmenorrhea increased as BMI increased. In fact, the difference in probability between the underweight and obese BMI groups was nearly significant at the 10% significance level with a p-value of 0.101. The differences between the other BMI groups were not significant.

Table 6

Estimates for the Logistic Regression Model by BMI Group in Younger Women (Ages 18-25)

$$\text{logit}(p) = \alpha + \beta_{\text{normal}}X + \beta_{\text{overweight}}X + \beta_{\text{obese}}X$$

| Parameter | Estimate | Standard Error | z-value | Two-tailed p-value |
|------------------------------------|----------|----------------|---------|--------------------|
| Intercept (Underweight BMI, <18.5) | -2.1079 | 0.2937 | -7.177 | <0.001 |
| Normal BMI [18.5,25) | -0.1405 | 0.3041 | -0.462 | 0.644 |
| Overweight BMI [25,30) | -0.1336 | 0.3241 | -0.412 | 0.680 |
| Obese BMI >30 | 0.1291 | 0.3324 | 0.388 | 0.698 |

Table 7

Probability of Younger Women in Each BMI Group of Having Dysmenorrhea

The above estimates for the model shown in Table 6 give us the following probabilities.

| BMI Group | Probability of Dysmenorrhea |
|-------------|-----------------------------|
| Underweight | 0.1083314 |
| Normal | 0.09548757 |
| Overweight | 0.09608518 |
| Obese | 0.1214468 |

Table 8

Estimates for the Logistic Regression Model by BMI Group in Older Women (Ages 26-40)

$$\text{logit}(p) = \alpha + \beta_{\text{normal}}X + \beta_{\text{overweight}}X + \beta_{\text{obese}}X$$

| Parameter | Estimate | Standard Error | z-value | Two-tailed p-value |
|------------------------------------|----------|----------------|---------|--------------------|
| Intercept (Underweight BMI, <18.5) | -2.9293 | 0.3879 | -7.551 | <0.001 |
| Normal BMI [18.5,25) | 0.2323 | 0.3972 | 0.585 | 0.559 |
| Overweight BMI [25,30) | 0.4517 | 0.4030 | 1.121 | 0.262 |
| Obese BMI >30 | 0.6599 | 0.4022 | 1.641 | 0.101 |

Table 9

Probability of Older Women in Each BMI Group of Having Dysmenorrhea

The above estimates for the model shown in Table 8 give us the following probabilities.

| BMI Group | Probability of Dysmenorrhea |
|-------------|-----------------------------|
| Underweight | 0.05072402 |
| Normal | 0.06315061 |
| Overweight | 0.0774435 |
| Obese | 0.09368915 |

Chapter 5: Discussion and Conclusions

Explanation of the Statistical Analyses Used

Logistic regression was selected as the main data analysis tool since such analyses are used to fit data when the data to be examined have been collected over a fixed period of time – in this case, between December 1, 2012, and November 30, 2013 – and the dependent variable is binary. In the present study, the value of the dependent variable was 0 for the non-dysmenorrhea group. Similarly, for the dysmenorrhea group, the value of the dependent variable was 1. Because there are only two options for the dependent variable, the variable is considered binary (Faraway, 2006).

A graph of the data will look like the plot in Figure 4, and logistic regression will fit a line to these data. The x-axis shows the independent variable, and the y-axis shows the dependent variable. Notice that all points have a y value of either 0 or 1, which would indicate either the presence or absence of dysmenorrhea, respectively. The equation of logistic regression for this study is as follows: $\text{Log}[p/(1-p)] = \alpha + \beta_{\text{normal}}X + \beta_{\text{overweight}}X + \beta_{\text{obese}}X$, where p is the probability of having dysmenorrhea. The computer fits the line to the points and decides the optimal β values for the equation above. Along with the β values, the computer gives a test statistic and p-value for these values. The p-value indicates whether or not the β value is statistically different from 0. If the p-value is greater than 0.05, it can be said that β is not significantly different from 0. The x values in the equation are either 1 or 0 and indicate which weight group a subject belongs to (Faraway, 2006).

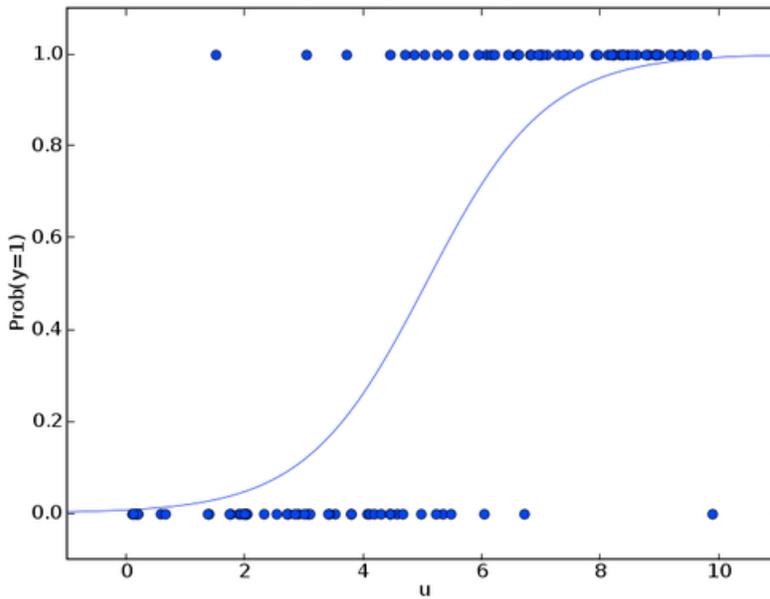


Figure 4. Logistic Regression Graph

To better illustrate this concept, consider the following example, which seeks to calculate the probability of an obese subject having dysmenorrhea. In this case, the value of x multiplied by β_{obese} would be 1 and the other x values would be 0. The values generated by the computer’s logistic regression fitted line are substituted into the equation (see Table 10):

$$\text{logit}(p) = -2.4765 + 0.0009x + 0.0853x + 0.2924x$$

Next, the x -values are substituted into the equation. Because our subject is obese, a 1 is substituted for the x value multiplied by the β_{obese} and 0 is substituted for the other x values:

$$\text{logit}(p) = -2.4765 + 0.0009(0) + 0.0853(0) + 0.2924(1)$$

In order to get the probability of having dysmenorrhea for an obese subject, the equation is solved for p , which is 0.1011874. It is important to note that in the equation there is no $\beta_{underweight}$. The α represents the underweight group, so to calculate the probability for the underweight group, all x values would equal 0.

Table 10

Example of Logistic Regression

$$\text{logit}(p) = \alpha + \beta_{\text{normal}}X + \beta_{\text{overweight}}X + \beta_{\text{obese}}X$$

| Parameter | Estimate | Standard Error | z-value | Two-tailed p-value |
|-----------------------------|----------|----------------|---------|--------------------|
| α Intercept | -2.4765 | 0.2328 | -10.637 | <0.001 |
| β_{normal} | 0.0009 | 0.2399 | 0.004 | 0.997 |
| $\beta_{\text{overweight}}$ | 0.0853 | 0.2479 | 0.344 | 0.731 |
| β_{obese} | 0.2924 | 0.2487 | 1.176 | 0.240 |

Notice, though, that the p-values for the β s are large, which means the β s are technically not significantly different from zero. If this is the case, the values in the equation above cannot be thought of as different from zero, so the equation becomes:

$$\text{logit}(p) = -2.4765 + 0x + 0x + 0x$$

Or more simply:

$$\text{logit}(p) = -2.4765$$

If this is the case, when the equation is solved for p, the probability will be the same regardless of the weight group (underweight, normal, overweight, or obese) of the individual. Thus, even though the probabilities of having dysmenorrhea for the 4 weight groups have been calculated, they cannot be thought of as significantly different from each other. The probabilities of all groups were calculated merely to explore the possible emergence of any patterns. In this particular example, the β values are not statistically significant. This may be because the difference in probability between groups is too small to detect. To detect small differences and have statistical significance, a very large sample size is necessary. If the groups really do have differences in probability of dysmenorrhea, a larger sample would be better able to detect the differences and have smaller p-values.

Discussion of the Results

As the data shows, the probability of experiencing dysmenorrhea is significantly larger for women in the younger age group (18 to 25) than for the older age group (26 to 40), which is consistent with previous research done on dysmenorrhea and age (Latthe, Mignini, Gray, Hills, & Khan, 1996).

When the data were examined from the perspective of BMI, however, there were no statistically significant differences in dysmenorrhea probabilities between women of different body weights, although there were some indications that the information was trending in certain directions. In particular, the probability of experiencing dysmenorrhea for the younger women was larger for both the underweight and obese BMI groups, although these differences were not statistically significant. A similar trend was seen among the older women, although in this group the difference in probability between the underweight and obese BMI groups was nearly significant at the 10% significance level. These results, while technically not significant, point to the possibility that dysmenorrhea is not influenced by BMI categories per se, but by extremes in body weight. We are well aware that people who are underweight and malnourished as well as people who are morbidly obese are prone to developing chronic physical maladies. Perhaps dysmenorrhea is yet another disease that is more likely to affect women who simply do not take care of their bodies. In the case of women who are underweight, they may be restricting calories which results in nutritional deficiencies that don't allow the body to function optimally. On the flip side, obese women may be overindulging in high-calorie/high-fat foods and neglecting to get enough exercise which also will be harmful to the body's normal physiologic processes.

Much like previous research on dysmenorrhea, the present study could not draw any definitive conclusions regarding the possible role of BMI in the development of dysmenorrhea. It is clear that more rigorous, systematic research on the risk factors involved in dysmenorrhea is needed before any firm conclusions can be drawn regarding the role of body weight in the disease. That being said, it is important to note that for future research to be valid there needs to be a better consensus among researchers and healthcare professionals alike as to what constitutes dysmenorrhea. A great starting point would be the development by an organization such as the American College of Obstetricians and Gynecologists (ACOG) of concrete diagnostic guidelines for primary dysmenorrhea, much like those that exist for secondary dysmenorrhea. One of the main reasons why prior research on this topic is so mixed is because not only are the diagnoses incredibly subjective, but there is no consistency in the types of assessment tools that are used. Until better methodologies are developed, attempts to combine data from across multiple studies will likely fail to show any meaningful patterns.

Limitations

There were several possible limitations in the present observational study. First, due to the fact that there are a multitude of potential risk factors involved in dysmenorrhea, it was impracticable to extract all such data points from the women's electronic medical records. Additionally, since pain is such a subjective topic and there is a lack of consensus among healthcare providers as to what constitutes primary dysmenorrhea, rates of diagnosis are wholly dependent on physicians' opinions rather than a quantitative value. Also, some women simply do not seek treatment for dysmenorrhea, so it is entirely possible that some women in the non-dysmenorrhea group had undocumented histories of debilitating menstrual

cramps. Finally, and perhaps most importantly, the size of the dysmenorrhea cohort (n=639) could have been too small to detect significant differences between the BMI sub-groups.

Recommendations for Further Research

Future research efforts on this topic must include a sufficient amount of data in order to be able to detect significant differences in the rates of dysmenorrhea in women of different BMI categories. The present observational study included data over one year; future research should strive to include data from at least a five year period. Additionally, future research efforts might involve excluding all women who have given birth in order to control for any differences due to nulliparity, since it has been shown that women with biological children have a lower incidence of dysmenorrhea (Latthe, Mignini, Gray, Hills, & Khan, 1996), although such information would likely have to be extracted in a time-consuming chart review rather than a simple data report run out of an electronic medical record database.

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