

# **Investigating Possible Correlation Between Models' Body Types and the Advent of Eating Disorders**

Mathematics SL Internal Assessment  
Candidate Number:

## Mathematics: SL Internal Assessment

### Introduction:

The modelling industry has been repeatedly criticized for only hiring and promoting a specific body type which- at least for women- tends to involve being very tall and thin. I am interested in this topic, not so much for the industry's ideals/ fashion trends, but for the potential social implications that this selection can have and the pertinence of this issue for girls my age. Many have argued that the modeling industry is a primary cause for social issues and the advent of eating disorders- something that affects a predicted 70 million individuals worldwide<sup>1</sup>- and that the fashion industry should take greater care in promoting a healthier and more balanced body-shape, which should be reflected in the models that they hire. The aim of this investigation therefore, is to see whether there is any validity to the claim that the modelling industry has an effect on the advent of eating disorders, through a mathematical analysis of the body-types of models and a comparison with statistics on eating disorders.

I chose to use BMI as a measure of body-type because it seemed to encapsulate the idea of body type, taking both height and weight into consideration, in a quantitative way. A person's BMI (Body Mass Index) is a measure of a person's health. Research has shown that people who fall within a certain category tend to live the longest and healthiest<sup>2</sup>- though it should be noted that there are various other factors such as cholesterol, physical activity and smoking that also influence health significantly. The formula is as follows:

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{Height}^2 \text{ (m)}}$$

With regards to the interpretation of results, the following categories are generally accepted:

BMI < 18.5 = underweight  
 18.5 ≤ BMI < 25 = normal  
 25.0 ≤ BMI < 30 = overweight  
 BMI ≥ 30 = obese

### Step 1)

To gain a more holistic view of the effects of the modeling industry, I decided to investigate the industry in two countries: USA and South Korea. These two countries

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<sup>1</sup> The National Eating Disorders Collaboration. (2012). *An Integrated Response to Complexity – National Eating Disorders Framework 2012*.

<sup>2</sup> "Body Mass Index." *Centers for Disease Control and Prevention*. Centers for Disease Control and Prevention, 06 Dec. 2013. Web. 16 Mar. 2014. < <http://www.cdc.gov/healthyweight/assessing/bmi/>.>

also have very a prominent fashion and modeling scene that is thought to play a large role in urban culture.

The first step was trying to find a list of models that would be representative of the ideals of the modeling industry. Consequently, I did some research and chose models from lists like 'Forbes' which based ranking on salary size and popularity (number of events, covers, photo-shoots etc.). I felt that this would be an accurate representation of what the industry- and the public- was interested in.

For the US model industry I selected the following models<sup>3</sup>:

Kate Moss
Famke Janssen
Lily Aldridge
Giselle Bundchen
Miranda Kerr
Marisa Miller
Adriana Lima
Allesandra Ambrosio
Heidi Klum
Kate Upton

NB: even though all of the models are not American, they are famous in the American modeling industry

For Korea, I selected the following- again the selection was according to lists which based ranking on salary size and popularity<sup>4</sup>.

<sup>3</sup> Bertoni, Steven, and Keren Blankfeld. "The World's Top-Earning Models." *Forbes*. Forbes Magazine, 05 May 2011. Web. 17 Mar. 2014. <<http://www.forbes.com/2011/05/05/top-earning-models.html>>

<sup>4</sup> "The Hottest South Korean Models." *Ranker*. N.p., n.d. Web. 17 Mar. 2014. <<http://www.ranker.com/list/hottest-south-korean-models/bikinibabehotties>>.

Lee Ji Woo
Kang Yoo Lee
Im Ji Hye
Hwang Mi Hee
Park Si Hyun
Choi Yu Jung
Park Hyun Sun
Kim Ha Yul
Park Soo Kyung
Song Hye Kyon

**Step 2)**

The next step involved gathering each model's height and weight data, sometimes converting it from pounds and inches/feet into kilograms and metres, and calculating their BMIs. I had some problems here with regards to finding accurate data as a lot of the information was from fan sites with dubious sources. Where possible, I tried to cross-reference and if not, I took the average value from the range that I found online<sup>5</sup>.

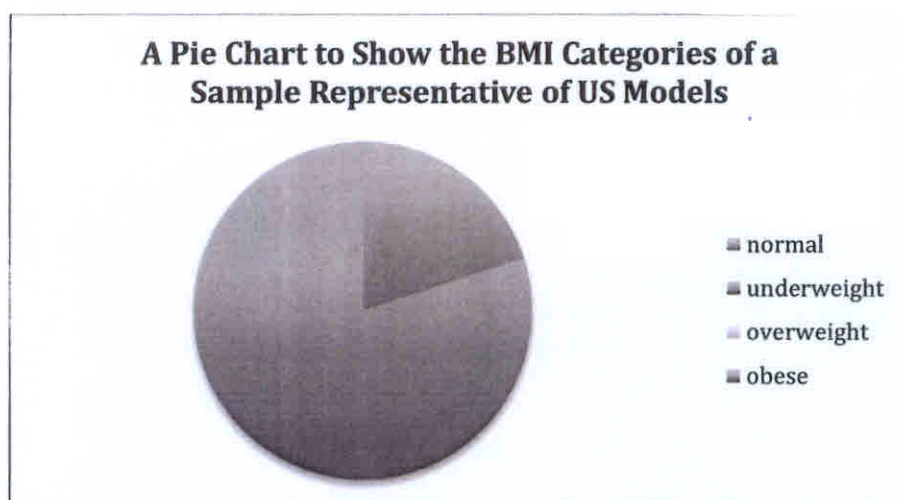
A Table to Show Average BMI of 10 American Models

Model	Height (m)	Weight (kg)	BMI
Kate Moss	1.70	48.0	16.6
Famke Janssen	1.83	61.4	23.9
Lily Aldridge	1.75	54.1	17.7
Giselle Bundchen	1.80	57.0	17.6
Miranda Kerr	1.75	54.0	17.6
Marisa Miller	1.71	52.3 <sup>6</sup>	17.9
Adriana Lima	1.78	55.0	17.4
Allessandra Ambrosio	1.76	51.0	16.5
Heidi Klum	1.77	62.0	19.8
Kate Upton	1.78	61.0	19.3
<b>Average</b>			<b>18.4</b>

Looking at the raw data, it can be seen that, apart from the last two models on the list, all of the models are classed as 'underweight' according to BMI and the average also falls in the 'underweight' category.

<sup>5</sup> Many internet sources used but main ones were: Bertoni, Steven, and Keren Blankfeld. "The World's Top-Earning Models." *Forbes*. Forbes Magazine, 05 May 2011. Web. 17 Mar. 2014. <http://www.forbes.com/2011/05/05/top-earning-models.html> and "The Hottest South Korean Models." *Ranker*. N.p., n.d. Web. 17 Mar. 2014. <<http://www.ranker.com/list/hottest-south-korean-models/bikini-babe-hotties>>.

<sup>6</sup> Dispute between 110-120 pounds so I selected 115



*Figure 1: A Pie Chart to Show the BMI Categories of US Models*

I then repeated this procedure for the 10 Korean models.

A Table to Show Average BMI of 10 Korean Models

Model	Height (m)	Weight (kg)	BMI
Lee Ji Woo	1.72	50.0	16.9
Kang Yoo Lee	1.78	53.0	16.7
Im Ji Hye	1.72	49.0	16.6
Hwang Mi Hee	1.74	51.0	16.8
Park Si Hyun	1.73	51.0	17.0
Choi Yu Jung	1.72	49.0	16.6
Park Hyun Sun	1.67	52.0	17.6
Kim Ha Yul	1.68	48.0	17.0
Park Soo Kyung	1.70	48.0	16.6
Song Hye Kyo	1.61	45.0	17.4
<b>Average</b>			<b>16.9</b>

Looking at these results, all of the models are classed as 'underweight' according to the BMI measure. The average is also lower than that of the American models which implies that beauty and ideals of the modelling industry is also possibly reflective of culture.



Figure 2: A Pie Chart to Show the BMI Categories of Korean Models

### Step 3)

To determine whether difference in the means is significant, I did some statistical analysis with the t-test.

The equation for standard deviation is:

$$s_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

$n$  = The number of data points

$\bar{x}$  = The mean of the  $x_i$

$x_i$  = Each of the values of the data

Figure 1: The Equation for Standard Deviation<sup>7</sup>

For the American models:

Average BMI	18.4
Standard deviation	2.07
Median (m)	17.7

For the Korean models:

Average BMI	16.9
Standard deviation	0.35
Median (m)	16.9

<sup>7</sup> "Standard Deviation." Maths Is Fun, 2013. Web. 30 Oct. 2013. <<http://www.mathsisfun.com/data/standard-deviation.html>>

From this, it can be seen that the Korean models have a lower average and median BMI suggesting that the models are thinner/ smaller. The standard deviation is also lower for the Korean models suggesting that there is less variation in the model sizes which implies greater selectivity.

However, in order to make conclusions from these results, it must first be determined whether or not the differences are significant. To determine this, there is a wide range of tests but, after conducting some research, I decided to conduct the student's t-test because the criteria fit (data from biological species, difference between means etc.)

To calculate the t-statistic<sup>8</sup>:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{SEM}$$

$\bar{x}_1 - \bar{x}_2$  = difference between the means

$$= 18.4 - 16.9$$

$$= 1.5$$

To calculate the 'standard error of the mean' (SEM):

$$SEM = \sqrt{\left(\frac{\text{var}_1}{n} + \frac{\text{var}_2}{n}\right)}$$

(variance = standard deviation<sup>2</sup>; n = sample size = 10)

Calculation of variance:

$$\text{var}_1 = 2.07^2 = 4.28$$

$$\text{var}_2 = 0.35^2 = 0.12$$

$$t = \frac{1.5}{\sqrt{\left(\frac{4.28}{10} + \frac{0.12}{10}\right)}} = 2.26$$

This value can be compared to a table of critical values as found in the appendix

NB: d.f. = degrees of freedom = sample size - 2

For this investigation, d.f. is 18 (20-2)

**Results of the t-test:** For there to be significance in results, P should equal 0.05 or less. It can be seen from above that the t-value for this experiment (2.26) is more than the critical t value for 18 degrees of freedom (2.1). This suggests that the difference between the 2 means is significant i.e. the probability of the difference occurring due to chance is less than 5%.

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<sup>8</sup> "Standard Deviation." Maths Is Fun, 2013. Web. 30 Oct. 2013. <<http://www.mathsisfun.com/data/standard-deviation.html>> and "T Test." Oklahoma State University, 1997. Web. 29 Oct. 2013.

The implications of this are that culture and geographical location affect the perception of the 'ideal' in the modeling world and this means that they could be having different effects on girls in different countries with regards to eating disorders. However, when looking at the raw data it is also clear that female models in Korea tend to be lighter and slightly shorter than their counterparts in the USA. Genes could also therefore play a part in the average BMIs.

#### Step 4)

To put the figures into context, I decided to compare the models' BMIs to the population averages for BMI. This meant that I had to find the data for the average heights and weights for the female population in the USA and Korea.<sup>9</sup>

A Table to Show Average BMI For Korean and American women

Country	Average Height (m)	Average weight (kg)	Average BMI
USA	1.64	73.6	27.3
Korea	1.63	56.5	21.4

According to the BMI categories, the average American female would be classed as 'overweight' whereas the average South Korean would be classed as 'normal'.

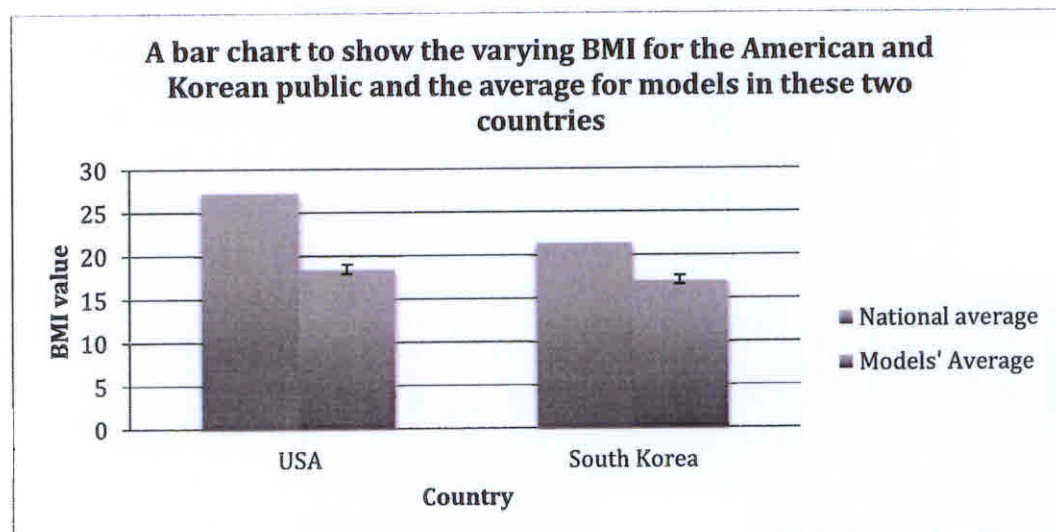


Figure 3: A comparison of the average model's BMI to the average woman's BMI  
NB: The error bars represent the previously calculated standard deviation.

<sup>9</sup> Holladay, April. "Women's Sizes by Country; The Age Group with the Best Memory - USATODAY.com." USA Today, 12 Feb. 2006. Web. 17 Mar. 2014. <[http://usatoday30.usatoday.com/tech/columnist/aprilholladay/2006-12-04-size-age\\_x.htm](http://usatoday30.usatoday.com/tech/columnist/aprilholladay/2006-12-04-size-age_x.htm)>. and Bond, Anthony. "Fattest Countries in the World Revealed: Extraordinary Graphic Charts the Average Body Mass Index of Men and Women in Every Country (with Some Surprising Results)." *Mail Online*. Associated Newspapers, 29 Mar. 2013. Web. 17 Mar. 2014. <<http://www.dailymail.co.uk/health/article-2301172>>.



From this graph, it can be seen that, though South Korea has the lower BMI in both regards, the difference between the population BMI and models' BMI is larger in the USA. This is potentially more serious in the context of the impact of the modeling industry on young girls as the difference between the 'ideal' and the reality is greater.

#### Step 4)

My final task was to see whether there was any correlation between the modelling industry's selective portrayal of body types and the advent of eating disorders. After reviewing the data that I had and raw statistics, I narrowed down my comparison to 2 variables: the ratio of the difference between model: average woman BMI, because this would seem to logically have the most impact as the extent of the effect of the distorted portrayal would likely depend on how far removed it is from reality, and the overall % of women with an eating disorder in each country.

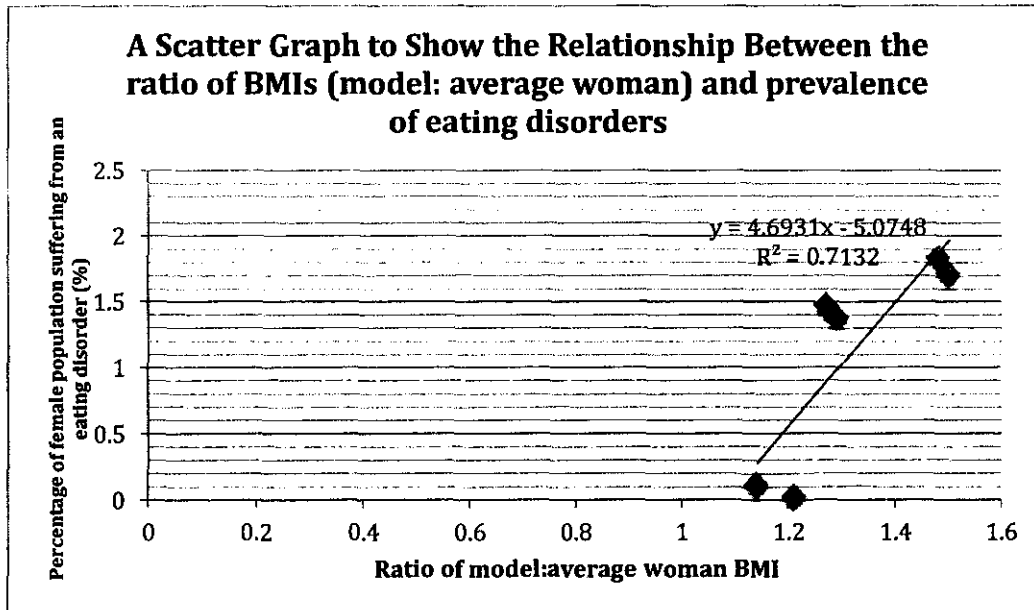
To allow for stronger analysis and for a valid conclusion to be drawn about the relationship, I got some more data using the same method as the one listed in step 1 and 2 for the following countries: Germany, UK, India and Japan. One serious problem that I faced was a discrepancy in the statistics for eating disorders. Many of them were specific to certain disorders (bulimia, anorexia, binge eating etc.) in which case, I averaged the percentages given. In other cases, like for India, there were very few sources available and I often had to take information from sites of dubious background. There were some other limitations to these results that will be mentioned in the conclusion.

A table to show the average BMI for models: average woman and the % of eating disorders in the country

Country	Average BMI for models	Ratio of model: average woman BMI	% of women with eating disorders (anorexia or bulimia nervosa for women of all ages) in the population <sup>10</sup>
USA	18.4	1.48	1.84
Korea	16.9	1.27	1.48
Germany	18.6	1.29	1.39
UK	17.8	1.50	1.72
India	18.73	1.21	0.03
Japan	17.1	1.14	0.12

<sup>10</sup> "Statistics by Country for Eating Disorders." - *RightDiagnosis.com*. N.p., 07 May 2013. Web. 17 Mar. 2014. <[http://www.rightdiagnosis.com/e/eating\\_disorders/stats-country.](http://www.rightdiagnosis.com/e/eating_disorders/stats-country.)>.

After plotting this data onto a scatter graph, I got the following results:



*Figure 4: The relationship between the ratio of model:average woman's BMI and the % of eating disorders in each country*

This graph suggests that, as the ratio of model: average woman's BMI increases- the difference becomes greater- the percentage of eating disorders increases. However, the  $R^2 = 0.71323$  which implies that there is only moderate correlation. Further implications will be discussed in the conclusion.

### **Conclusion:**

Looking at the graph in step 4 of this investigation, there is a suggestion that, as the gap between the BMI and body-shape of models and the average woman increases, the % of the population with eating disorders increases. This then supports the claim made in the introduction of this investigation whereby it was posed that the modeling industry was responsible for promoting an unhealthy body type that could potentially lead to social problems like eating disorders. The implications of this are significant as it may imply that the industry needs to take further responsibility for its actions and selection procedure. However, the  $R^2$  is 0.71323 which suggests only moderate correlation. Moreover, correlation studies do not establish cause and effect and so it can be argued fairly that various other factors, like depression, education and other forms of media can have just as large an impact on the on-set of eating disorders. Furthermore, there were many other flaws in this investigation: firstly, my sample size for determining average model's BMI was very small- only 10 models were selected from each country- which may give a distorted view on each country's

modelling industry's 'ideal' body. I also did not do justice to their efforts to change their view on body types- I completely omitted the role of plus size models, for instance. Moreover, there was also the possible inaccuracy of my sources for the data and the fact that it is common for cases of eating disorders to go unreported- especially in more conservative cultures which perhaps explains the low percentages for India and Japan: it is estimated that the true incidence of bulimia alone is to be 1 in 5 amongst students and women globally.<sup>11</sup> When calculating the average BMI of the population, I did not take into consideration things like age, the possibility of pregnant women etc. Lastly, it must be noted that BMI is not an absolute measure of healthiness or how thin a person is- some people are naturally heavier/ lighter.

However, despite these flaws, I learnt a lot from this experience, as I was able to research a topic of my own interest and sort through information and data critically. The need for reliable sources and the lack of it being a major limitation was also something that I had not properly considered before undertaking this project. If I were to repeat the investigation, I would probably focus more on countries where more widespread surveys statistics were available and limit it to impact in cities. In India for example, the effect of modelling cannot be properly measure because many members of the population are under-nourished due to food shortages rather than eating disorders. It would also be interesting to focus on the effects of the industry on specific cultures and on men, who make up 10-15% of anorexia nervosa victims<sup>12</sup>.

**Word count: 2275**

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<sup>11</sup> The National Eating Disorders Collaboration. (2012). *An Integrated Response to Complexity – National Eating Disorders Framework 2012*.

<sup>12</sup> Ibid

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