



# Correlation of Foot Dysfunctions and Body Mass Index in Pregnancy

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## Abstract

**Background:** As women gets pregnant, many changes take place in her body like physiological changes, hormonal changes leading to increase in joint laxity, experiences increase in weight gain which leads to many of the musculoskeletal disorders. Pregnant women experience many musculoskeletal problems which are common like lower back pain, leg pain, foot pain etc. Among all of the musculoskeletal dysfunctions, foot of pregnant women has many problems and which is not known to the people. As we all know that, various foot dysfunctions like calf muscle cramps, foot pain, swelling around ankles, heel pain on standing occur most commonly during second and third trimester of pregnancy. There is lack of knowledge seen whether there is any correlation seen among foot dysfunctions and body mass index during the pregnancy. **Purpose:** This study was done to check whether these incidences of various foot dysfunctions with increase in the body mass index of the pregnant women are correlated. **Aim:** To identify the correlation of foot dysfunctions and increase in body mass index during pregnancy. **Methods:** In this study, 160 participants between 20-35 years were selected for this study. According to the inclusion criteria, women who were pregnant for the first time were included in this study whereas pregnant women with complications such as polyhydraminos, fibroid complicating pregnancy were excluded in this study. Participants were given written as well as verbal informed consent. They were divided into group of four according to World Health organization of the body mass index categories. **Statistics:** Pearson's correlation of InStat software was used to calculate statistics. **Results:** According to the data, it could be seen that extremely strong relation seen between pain and obese women ( $p = 0.0008$ ) whereas no significant relation was found in underweight ( $p = 0.1501$ ) and normal ( $p = 0.1420$ ) women. Also very significant correlation was found between disability and women who was obese ( $p = 0.0084$ ) whereas, no relation was found in women who were underweight, normal and overweight ( $p = 0.3390, 0.1919, 0.1513$ ). Women's with normal body mass index found extremely significant relation ( $p = 0.0001$ ) with activity limitation, whereas, significant relation with underweight, obese and overweight ( $p = 0.0413, 0.0010, 0.0114$ ) pregnant women. Visual Analogue Scale (VAS) also showed significant correlation with all of the pregnant women. And overall total score of Foot Function Index (FFI) found extremely significant relation with women who were overweight ( $p = <0.0001$ ). **Conclusions:** This study concludes that there is strong correlation between the foot dysfunction and body mass index in pregnant women who are overweight. As the weight gain increases during pregnancy there is more incidence of foot dysfunctions and which affects the ability of the women to do the daily activities. By seeing this correlation, proper preventive plans must be executed.

**Keywords:** Foot Dysfunctions, Foot Function Index, Overweight, Pregnancy, Visual Analogue Scale

## 1. Introduction

For every woman to be pregnant is most wonderful feeling in the world. For them, the period of pregnancy must be a feeling to be blessed without any complications. Then slowly she complains of back pain, leg pain, etc. and then she learns that many of the changes are taking place in her body. Many of these women do not take concern about these discomforts and when

these discomforts starts intervening her daily activities then she seek the medical help. It is seen that, during pregnancy, as there is enlargement of her uterus, as fertilization starts, many of the anatomical as well as physiological changes occur in the women's body<sup>1</sup>. The most common bodily changes that occur during pregnancy are increase in weight of the women, change in the posture, there is more mobility in the joints due to increase in abdominal volume as the fetus grows there is

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increase in lordosis, increase in thoracic extension, shift of center of mass anteriorly and there is decrease in strength of abdominal muscles. During the period of pregnancy, as we all know that there is accumulation of fat and fluid in the body which is normal, there is increase in body mass for an average of 11-16 kg. This enlargement increases pressure on women's foot health and result in variety of the foot problems as well as other foot symptoms<sup>2-9</sup>. These all of the factors are seen to urge a negative effect on health of the women. Approximately 75% of women complain of lower back as well as foot pain<sup>10</sup>. They are probably told that the pain they are experiencing during pregnancy is considered normal, and they will have to acquire the knowledge of how to cope up to the pain as it will remain for the remaining period of the pregnancy<sup>11</sup> are most commonly reported and investigated earlier. But, as we know that during pregnancy women have foot pain and is known to all, there is a lack of knowledge regarding foot dysfunctions which are seen commonly in pregnancy.

According to the previous studies, the commonly reported musculoskeletal dysfunctions during the period of pregnancy were cramps in the calf, pain on the heel while standing for long time, pins and needles in the foot, swelling around the ankles and foot pain<sup>12</sup>. Previous studies have reported that these musculoskeletal problems that continue during the pregnancy are more prone to develop lower limb musculoskeletal problems in parous women rather in the women who is nulliparae<sup>13</sup>. During pregnancy, for women most of the body weight comes on her foot. Pregnant women with overweight or obese category of body mass index found to be a main factor correlated with foot health and foot pain<sup>14</sup>. Hence, in human's body, foot plays a main role of maintaining the weight of the body, maintaining balance of the body as well as absorbing ground reaction forces generated during daily activities. So, it is important to classify pregnant women according to their body mass index as described by WHO-Underweight (<18.5 kg/m<sup>2</sup>), normal (18.5-24.9 kg/m<sup>2</sup>), overweight (25.0-29.9 kg/m<sup>2</sup>), obese (>30 kg/m<sup>2</sup>) and obese grade 1 (30.0-34.9 kg/m<sup>2</sup>), grade 2 (34.9-40.0 kg/m<sup>2</sup>), grade 3 (>40 kg/m<sup>2</sup>).

In obese women, during pregnancy, all of their body weight come on their feet, it is continuously exposed to weight bearing. In pregnant women, weight gain is about 1.2 times the body weight in the feet during their normal gait, whereas, pregnant women who are obese, weight bearing on medial longitudinal is about 3 times greater as compared to the normal individuals<sup>15,16</sup>. Hence, this can cause negative biodynamic changes that decrease the quality of life and restrict the physical activity. Hence, decrease in the physical activity leads to decrease in the muscle strength due to the restricted range of motion. Hence, this may be the result of increased reports of foot pain. Women usually complains of trouble in performing the daily living activities associated with various foot dysfunctions like heel

pain, foot pain, calf muscle cramps, etc. In all of the previous studies, various foot problems as well as foot dysfunctions are reported in various trimesters of pregnancy. But there has been lack of literature regarding body mass index and foot problems in pregnant women. This study was carried out to check the correlation of body mass index and foot dysfunctions and to identify whether the change in the body mass index will affect the foot function and activities of daily living.

## 2. Methods and Materials

### 2.1 Selection of the Participants

Pregnant women with the age of 20-35 years and women who was pregnant for first time were selected for this study. These participants were screened in the Krishna Institute of Medical Sciences Deemed to be University.

### 2.2 Study Type

This was an observational study which was held to check the correlation of foot dysfunctions and body mass index in pregnant women with the help of Foot Function Index Scale as the outcome measure.

### 2.3 Sample Size Method

According to the inclusion and exclusion criteria, simple random sampling was used to select the participants for this study.

### 2.4 Calculation of the Sample Size

According to the parent article,

$$N = 70$$

But, in this study 160 primiparae pregnant women of different trimesters as well as body mass index were included in this study.

### 2.5 Inclusion Criteria

- Primiparae pregnant women.
- Pregnant women between the age group of 20-35 years.

### 2.6 Exclusion Criteria

- Pregnant women with complication like polyhydraminos.
- Pregnant women with fibroid complicating pregnancy.
- Pregnant women with multiple pregnancies.

## 2.7 Objective

The objective of the study is to recognize whether there is correlation of body mass index and foot problems in pregnancy.

## 2.8 Procedure

Pregnant women with age range of 20-35 years were screened from Krishna Hospital, Karad and Campus of the same institute. Around 160 primiparae pregnant women were screened. Pregnant women with polyhydramnios, fibroid complicating pregnancy, multiple pregnancies were excluded in this study. All patients were explained about the study procedure and benefits of the current research work along with the written consent and verbal informed consent was given to the participants. Demographic information including name, age, height, weight, trimester, number of delivery was taken. Then after this women were divided into group of four according to World Health Organization of the body mass index categories. Further assessment was taken by using a scale named Foot Function Index which included three sub-scales: Pain, disability, activity limitation. Foot Function Index was used to analyze foot problems of these women. Visual Analogue scale was also used in Foot Function Index scale to check the extent of pain severity of these women.

## 2.9 Outcome Measures

In this study foot function scale is used.

### 2.9.1 Description of Index

Foot Function Index (FFI) contains 23 items and was divided into three parts. These parts were done to describe the three features of function - pain in foot, disability and limitation in the daily activities. The items were chosen in a way to describe how these foot problems affect the foot's function.

### 2.9.2 Dimensions to Measure

These items are scored by using Visual Analogue Scale (VAS). This scale includes a horizontal line which was equally divided

into 10 segments. In this scale 0 represents no pain and 10 represents worst pain. Then participant was asked about to what extent is the pain at present. The first part of the scale consists of pain component which measures the extent of foot pain in different situations and includes nine items. The second part of the scale consists of disability which measures inability to perform activities due to foot problem and contains 9 items and when measured on Visual Analogue Scale, 0 measures no difficulty whereas, 10 measures so difficult unable. The last part of the scale consists of activity limitation which measures the limitation to do activities and consists of 5 items and when measured on Visual Analogue Scale, 0 measures none of the time, whereas, 10 measures all of the time.

### 2.9.3 Method to Score

This scale is scored on the basis of extent of severity of the abnormal functioning of the foot function, pain severity and limitation in daily activities. This score is calculated for 23 items on Visual Analogue Scale which is equally divided in 10 parts. To calculate the score of the first part of the scale, score of the items of the first part are totaled and are then divided by the total score of that part and in this way all of the three part of the scale are scored. Total score of the scale is calculated by adding all of the scores of three parts and dividing it by the score of the scale. Now, if participant says that any one of the activity she doesn't perform then that item is not marked and is not included in total score. Usually score is multiplied by 100 to exclude the decimal point.

## 3. Results

Results were evaluated by using the Pearson's correlation method of the Instat software. A total of 160 pregnant women of age between 20-35 years were included and their age wise distribution as well as trimester and body mass index wise distribution is shown in Table 1. The intensity of pain was measured on visual analogue scale and their correlation to the four categories of body mass index of pregnant women is seen

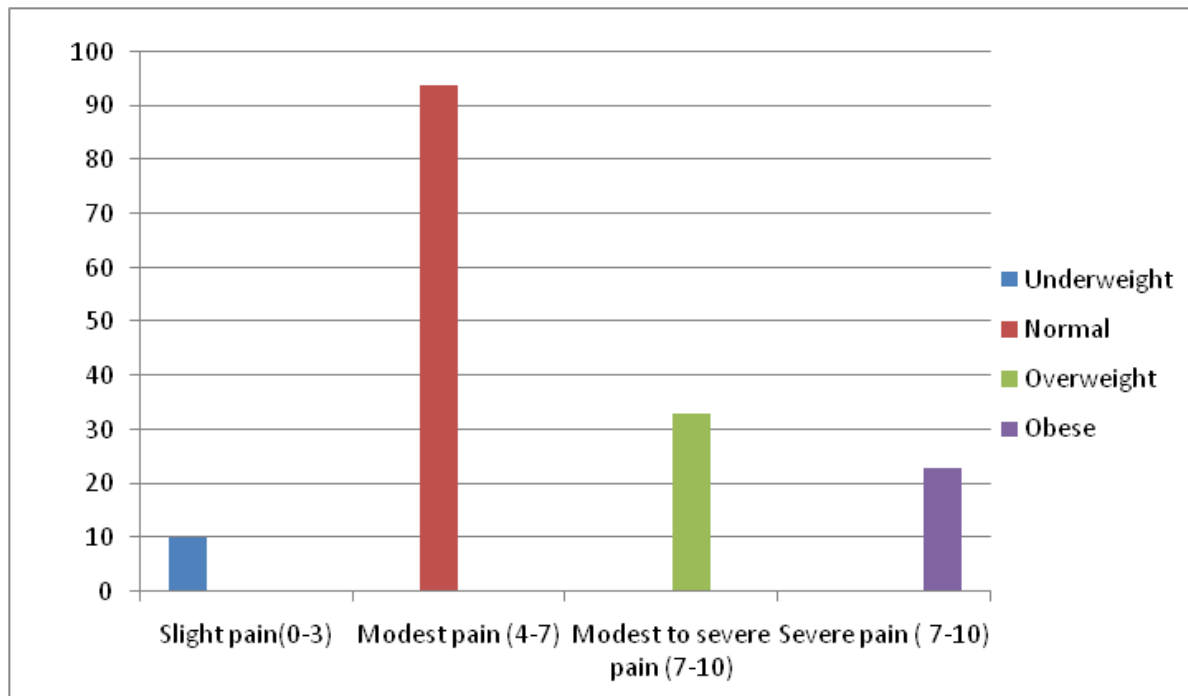
**Table 1.** Data including all the demographics of the pregnant women

Variables	Frequency of pregnant women	% of pregnant women	Mean ± Standard deviation
1. Age-			
a. 20-25 years	81	50%	22.68 ± 1.76
b. 26-30 years	59	36%	27.85 ± 1.24
c. 31-35 years	20	12%	33.1 ± 1.29
2. Body mass index-			
a. Underweight (<18.5 kg/m <sup>2</sup> )	10	6%	17.023 ± 0.72
b. Normal (18.5-24.9 kg/m <sup>2</sup> )	94	58%	21.57 ± 1.74

c. Overweight ( 25.0-29.9 kg/m <sup>2</sup> )	33	20%	27.87 ± 1.51
d. Obese ( >30 kg/m <sup>2</sup> )	23	14%	32.28 ± 2.98
3. Trimester -			
a. First Trimester	25	15%	
b. Second Trimester	65	40%	
c. Third Trimester	70	43%	

**Table 2.** Statistics results of Visual Analogue Scale showing association among the four of categories of the body mass index

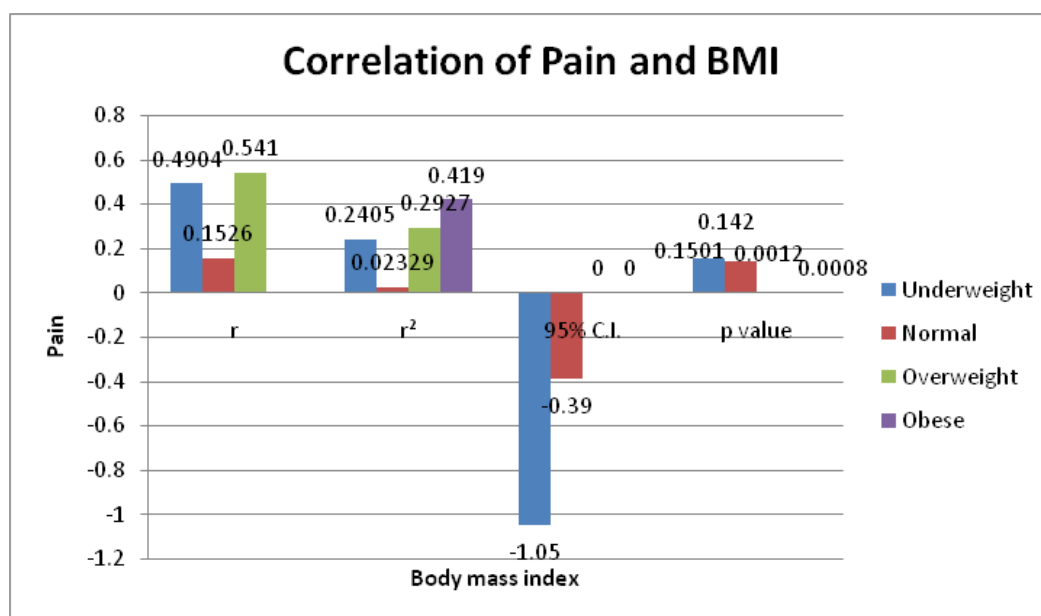
Visual analogue scale	Mean and standard deviation	p value	Severity of pain
1. Underweight	(1.5 ± 0.47)	0.0056	Mild pain
2. Normal	(3.68 ± 0.93)	<0.0001	Moderate pain
3. Overweight	(6.40 ± 0.67)	<0.0001	Moderate to Severe pain
4. Obese	(7.45 ± 0.52)	<0.0001	Severe pain



**Graph 1.** Graphical representation of visual analogue scale in relation to body mass index of pregnant women.

**Table 3.** Statistics results of pain showing association among the four of categories of the body mass index

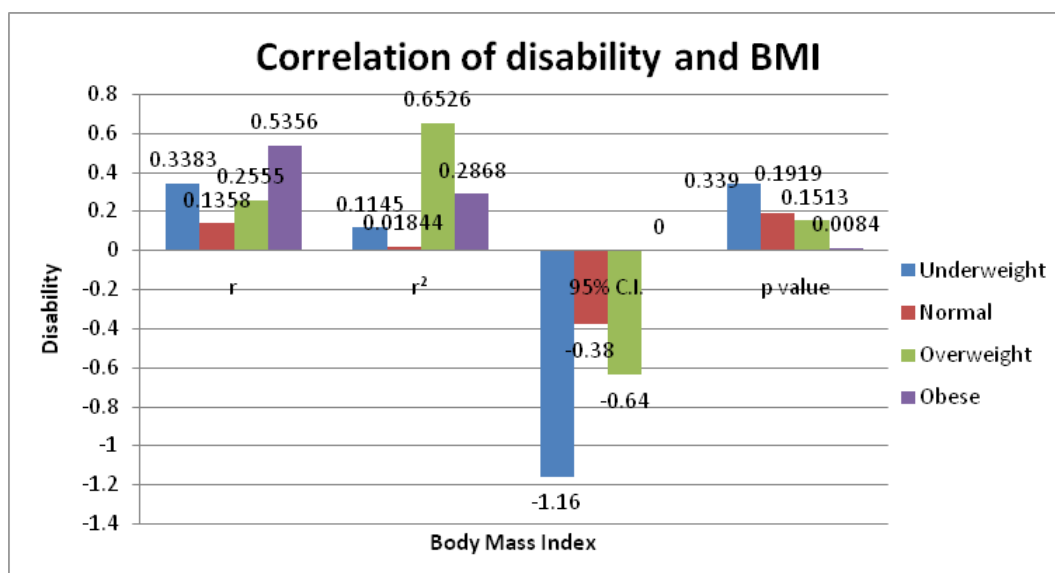
Pain	Underweight	Normal	Overweight	Obese
r	0.4904	0.1526	0.5410	0.6473
r <sup>2</sup>	0.2405	0.02329	0.2927	0.4190
95% confidence interval	(-0.20-0.85)	(-0.05-0.34)	(0.24-0.74)	(0.32-0.83)
p value	0.1501	0.1420	0.0012	0.0008
Result	Insignificant	Insignificant	Very significant	Extremely significant



**Graph 2.** Statistical analysis of pain representing comparison between the four of categories of the body mass index.

**Table 4.** Statistical analysis of disability representing comparison between the four of categories of the body mass index

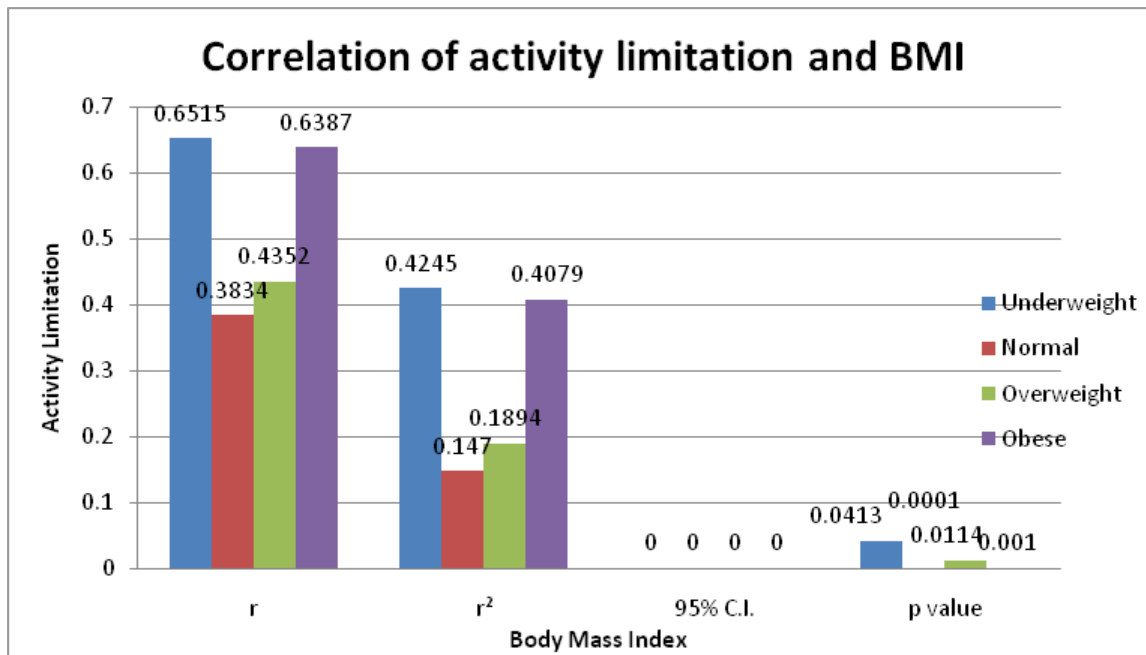
Disability	Underweight	Normal	Overweight	Obese
R	0.3383	0.1358	0.2555	0.5356
r <sup>2</sup>	0.1145	0.01844	0.6526	0.2868
95% confidence interval	(-0.37-0.79)	(-0.06-0.32)	(-0.09-0.55)	(0.15-0.77)
p value	0.3390	0.1919	0.1513	0.0084
Result	Insignificant	Insignificant	Insignificant	Very significant



**Graph 3.** Statistics results of disability showing the association among the four of categories of the body mass index.

**Table 5.** Statistics results of activity limitation showing the association among the four of categories of the body mass index

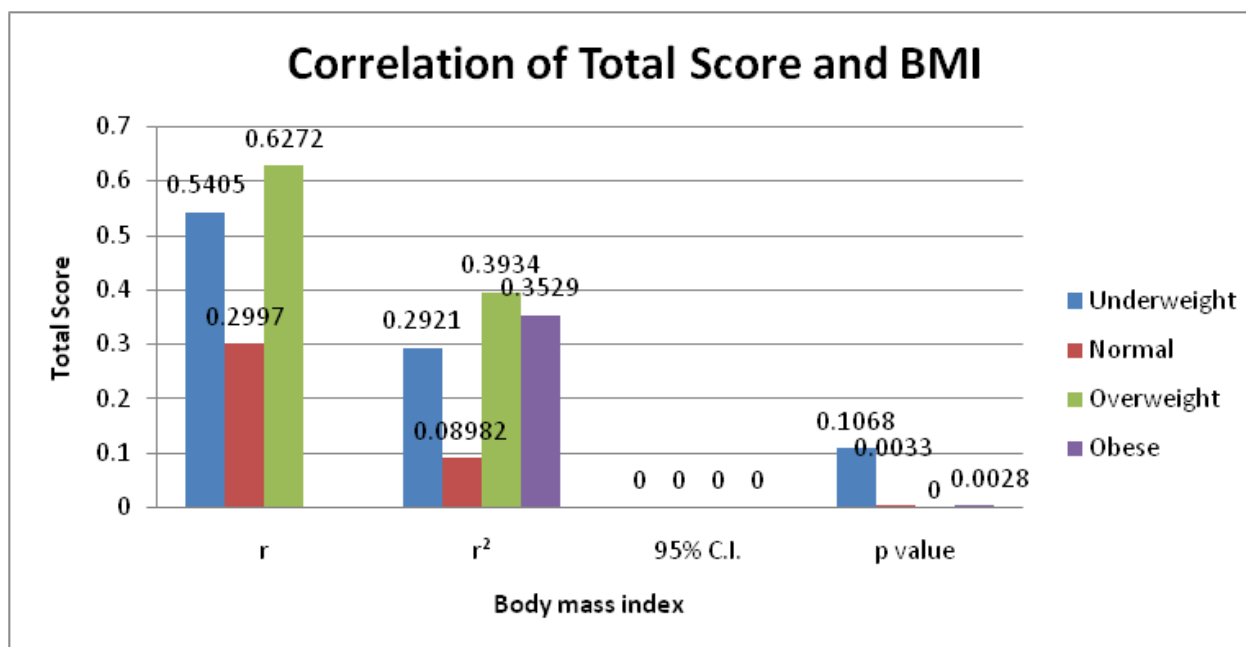
Activity limitation	Underweight	Normal	Overweight	Obese
R	0.6515	0.3834	0.4352	0.6387
r <sup>2</sup>	0.4245	0.1470	0.1894	0.4079
p value	0.0413	0.0001	0.0114	0.0010
95% confidence interval	(0.36-0.90)	(0.19-0.54)	(0.10-0.67)	(0.30-0.83)
Result	Considered significant	Extremely significant	Considered significant	Very significant



**Graph 4.** Statistical analysis of activity limitation representing comparison between the four of categories of the body mass index.

**Table 6.** Statistical analysis of total score of Foot Function Index representing comparison between the four of categories of the body mass index

Total Score	Underweight	Normal	Overweight	Obese
R	0.5405	0.2997	0.6272	0.5941
r <sup>2</sup>	0.2921	0.08982	0.3934	0.3529
p value	0.1068	0.0033	<0.0001	0.0028
95% confidence interval	(-0.13-0.87)	(0.10-0.47)	(0.36-0.79)	(0.24-0.80)
Result	Not significant	Very significant	Extremely significant	Very significant



**Graph 5.** Statistical analysis of total score of Foot Function Index representing comparison between the four of categories of the body mass index.

in Table 2 and Graph 1. The statistical analysis of body mass index and its correlation to pain, disability, activity limitation and total score of the Foot Function Index is shown in Tables 3-6 and Graphs 2-5.

## 4. Discussion

As women gets pregnant, many changes take place in her body like physiological changes, hormonal changes leading to increase in joint laxity, experiences increase in weight gain which leads to many of the musculoskeletal disorders. Pregnant women experience many musculoskeletal problems which are common like lower back pain, leg pain, foot pain etc. They are probably told that the pain they are experiencing during pregnancy is considered normal and they will have to acquire the knowledge of how to cope up to the pain as it will remain for the remaining period of the pregnancy<sup>11</sup>. Previous studies have been done to appreciate the prevalence of lower back pain during the period of pregnancy, but very few studies have estimated the effect of pregnancy on her foot and overall health<sup>17</sup>. In this study, the correlation between body mass index and foot dysfunctions like foot pain, calf muscle cramps, heel pain on standing, swelling etc. is seen by using Foot Function Index (FFI) scale as an outcome measure. Many studies have been undertaken on foot problems and various foot dysfunctions like foot pain, heel pain on standing, calf muscle cramps etc. Despite its widespread prevalence of foot dysfunctions in various trimesters of pregnancy, no

research has been conducted on correlation of body mass index and foot dysfunctions in pregnant women. Women are disproportionately affected by musculoskeletal dysfunctions like muscle cramps in the calf, foot pain, back pain and pelvic girdle pain in their second and third trimester<sup>18</sup>.

Approximately, 75% of women have been seen complaining of lower back as well as foot pain problems<sup>10</sup>. During pregnancy, it is known that mostly, pregnant women are told that back pain and foot problems are a normal incidence occurring during pregnancy and that they will have to be trained to cope up with the pain for the rest of the period of the pregnancy<sup>11</sup>. According to the previous studies, the commonly reported musculoskeletal dysfunctions during the period of pregnancy were cramps in the calf, pain on the heel while standing for long time, pins and needles in the foot, swelling around the ankles and foot pain<sup>12</sup>.

During pregnancy, for women most of the body weight comes on her foot. Pregnant woman with overweight or obese body mass index is seen to be a main factor associated with foot pain and foot health<sup>14</sup>. In obese women their feet is continuously exposed to weight bearing of whole body. In one of the previous study it is seen that during normal gait, weight gain is about 1.2 times whereas obese women is about 3 times greater than normal individuals<sup>15,16</sup>. One study was done to estimate the occurrence of back pain during the period of pregnancy, and estimated the effect of pregnancy on problems of the foot<sup>17</sup>.

Present study, shows the correlation between body mass index and foot dysfunctions like foot pain, calf muscle cramps, heel pain on standing, swelling etc. is seen by using Foot Function Index (FFI) scale. This scale is a simple scale and so difference due to many errors cannot occur. Previous studies have reported the significant change in the health of the foot as well as limitations in the daily activities of pregnant women<sup>19</sup>. This concluded that this pregnancy have a negative influence on the health of the foot. These foot changes that would occur during the period of pregnancy were unknown to these women. Hence, these women didn't anticipate to change the status of the foot during the period of pregnancy. Obese women reported more pain while standing for long periods of time and difficulty in walking to the shops and climbing stairs because of the foot dysfunctions which developed during the pregnancy. These all results in decline in the function of foot and also results in decline in quality of life of these pregnant women.

Obese women were found to have the highest ratio of foot pain. One of the previous study evaluated the relation of increase in the body mass index and pain in the foot<sup>14</sup> and fat mass<sup>20</sup>. Furthermore, Vullo, Richardson (1996)<sup>21</sup> reported about foot pain that it mainly starts after three months of the pregnancy. Other study was done, in which almost half of the percentage of the pregnant women evaluated the foot problems which includes unsteady gait and swelling in whole of the leg including the foot<sup>22</sup>. During pregnancy, due to weight gain, edema, foot underwent many changes usually after three months of the pregnancy. This period of pregnancy impacts the overall structure and function of the foot, resulting to the inappropriate position of the foot which leads to onset of the pain. These deviations of the gait increases the severity of the foot pain in the next phases of pregnancy, resulting for the increase in the incidence of various discomforts including musculoskeletal and decline in their quality of life. Pregnant women have higher midfoot pressures, higher hindfoot pressures and lower forefoot pressures. Pregnant women have a wider step width to maximize the stability in the stance phase and to control the mediolateral motion.

This study evaluates the need to gain the knowledge required about various changes that occur in the foot during the pregnancy by health care professionals. They should also be educated about how to prevent these discomforts during pregnancy. Improved care of the pregnant women leads to better results of the foot function as well as improves the quality of life of these women. These women should also know about prevention of these foot dysfunctions like foot pain, swelling etc. in the pregnant women as their body mass increases, hence the study.

## 5. Conclusion

This study concludes that there is strong correlation between the foot dysfunction and body mass index in pregnant women who are overweight. As the weight gain increases during pregnancy there is more incidence of foot dysfunctions and which affects the ability of the women to do the daily activities. By seeing this correlation, proper preventive plans must be executed.

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