

ASSOCIATION OF METABOLIC SYNDROME WITH DEVELOPMENT OF PRE-ECLAMPSIA AMONG PREGNANT WOMEN

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ABSTRACT

Background: Preeclampsia is a complicated disorder in pregnancy which occurs after 20 weeks of gestation. It affects 3-5% of all pregnancies in the world. It has been reported that the prevalence of preeclampsia has been altered between 1.8% and 16.7% in developing countries Women with preeclampsia seem to be at elevated risk for cardiovascular disease.

Objective: This study was done to determine the relation between metabolic syndrome and occurrence of pre-eclampsia and to evaluate the use of metabolic score in determining the development and severity of pre-eclampsia.

Methods: This is a case-control study includes women attending to obstetric emergency unit in labour. The period of study was about 24 month from January 2017 to December 2018. The cases were divided into two groups: The first group consists of 300 cases with pre-eclampsia which characterized by: Mild pre-eclampsia as blood pressure higher than 140/85 and protein 1+ or greater by dip stick, moderate pre-eclampsia blood pressure is more than 140/85 and less than 160/100 and protein 1+ or greater by dip stick. Severe pre-eclampsia (imminent-eclampsia) or blood pressure is higher than 160/100 and protein greater than 3+ by dip stick. The second group consists of 300 control patients with normal pregnancy.

Results: Preeclampsia was a dependent risk factors for metabolic syndrome (adjusted odds ratio = 6.888, 95% CI = 4.656 to 10.189, P-value <0.0001). While age category 40-49 years was associated with significantly lower risk for metabolic syndrome as referenced to age category 18-29 years adjusted odds ratio = 0.337, 95% CI = 0.168 to 0.677, P-value = 0.002).

Conclusion: There is a significant relation between the incidence of PE and presence of metabolic syndrome and the more number of items of metabolic syndrome the higher the risk of occurrence of PE.

Keywords: Metabolic syndrome; pre-eclampsia

INTRODUCTION

Preeclampsia is a complicated disorder in pregnancy which occurs after 20 weeks of gestation. It affects 3-5% of all pregnancies in the world It has been reported that the prevalence of preeclampsia has been altered between 1.8% and 16.7% in developing countries Women with preeclampsia seem to be at elevated risk for cardiovascular disease (*Osungbade and Ige, 2011*).

Studies have shown that women with preeclampsia disease show two times risk of cardiac disease, cardiovascular mortality, cerebrovascular and peripheral arterial disease. It has been indicated that many risk factors such as diabetes mellitus, obesity, hypertension and heart disease is often common in preeclampsia and cardiovascular disease patients. There are also another risk factors for preeclampsia include elevated body mass index (BMI) before or during pregnancy, pre-existing diabetes, multiple pregnancies, null parity, autoimmune disease, renal disease and maternal age greater than 40 years old (*Duckitt and Harrington, 2005; Miranda et al., 2005*).

The metabolic syndrome is defined as a cluster of metabolic abnormalities such as hypertension, dyslipidaemia, obesity (particularly central obesity), insulin resistance and high fasting plasma glucose. Differences in genetic differences, diet, physical activity, age and sex influence the prevalence of metabolic syndrome and its components pregnancy induced hypertension, respectively. Assessment of the metabolic syndrome may prevent some pregnancy complications (*Praramsothy and Knopp, 2008*).

It has been reported that dyslipidaemia and insulin resistance are more considerable in preeclampsia women when compared to normal pregnancy, many studies have been shown that there are associations between pre pregnancy obesity chronic hypertension dyslipidemia, and inflammation in early pregnancy and high risk of preterm birth and intrauterine growth restriction. Studies have indicated that people with metabolic syndrome reveal higher frequency of cardiovascular disease and more rate of death from cardiovascular disease (*Catov et al., 2008; Galassi et al., 2006*).

Patients with high triglyceride show a higher incidence of preeclampsia many studies have indicated high triglycerides, cholesterol, low density lipoprotein (LDL) and reduced high density lipoprotein (HDL) levels in preeclampsia. Another study also revealed that obesity is a risk factor for the progression of PE (*Ogura et al., 2002*).

AIM OF THE WORK

This study was done to study the relation between metabolic syndrome and occurrence of pre-eclampsia and to evaluate the use of metabolic score in determining the development and severity of pre-eclampsia.

PATIENTS AND METHODS

This is a case-control study includes women attending to obstetric emergency unit in labour in Bolak El Dakror General Hospital. The period of study was about 24 month from January 2017 to December 2018. The studied group was divided into two groups: The first group consists of 300 cases (pregnant women with pre-eclampsia) which characterized by: Mild pre-eclampsia as blood pressure higher in 140/85 and protein 1+ or greater by drip stik. Moderate pre-eclampsia blood pressure is more than 140/85 and less than 160/100 and protein 1+ or greater by drip stik. Severe pre-eclampsia (imminent-eclampsia) or blood pressure is higher than 160/100 and protein greater than 3+ by drip stik. The second group consists of 300 control pregnant women with normal pregnancy.

For the cases and controls:

The blood pressure was measured by using a standard mercury manometer with the women in sitting position from their right arms so that, patients with systolic blood pressure equal or more than 140, diastolic blood pressure equal or more than 85 was diagnosed as hypertensive women.

Body mass index BMI was calculated by weighting the patient and measuring the height, so:

- BMI less than 30 → not obese
- BMI 30-34 → obese
- BMI more than 35 → morbid obesity

Blood glucose level is measured, so, if more than 100 g/ml the woman is diabetic

- High density lipoprotein (HDL) is equal or less than 50.
- Triglycerides (TG) is equal or more than 250.
- Protein in urine was measured by dripstik.

Definition of metabolic syndrome (MS) included the following components:

- 1- Pre-existing hypertension
- 2- Diabetes whether gestational or pre-gestational.
- 3- Body mass index (BMI) equal or more than 30 kg/m².
- 4- High density lipoprotein (HDL) equal or less than 50 mg/ml.
- 5- Triglycerides (TG) equal or more than 250 mg/ml.

The presence of MS was defined as having three of the five variables assessed using the clinical cut off defined above.

Patients were included in the study according to the following criteria: Gestational age equal or more than 37 weeks. Glucose level equal or more than 100 mg/ml, HDL ≤50 mg/ml, TG ≥250, BMI ≥ 30, and blood pressure equal or more than 140/85.

Exclusion criteria

- 1- Gestational age less than 37 weeks.
- 2- Glucose level less than 100, HDL > 50 mg/ml, TG \leq 250 mg/ml.
- 3- Blood pressure less than 140/85.
- 4- History of renal, cardiovascular, liver, endocrine disorder or any chronic illness.

Statistical methods:

Data were analyzed using IBM© SPSS© Statistics version 23 (IBM© Corp., Armonk, NY) and JMP® Version 13.2.1 (SAS© Institute Inc., Cary, NC). Categorical data were presented as number and percentage and between-group differences were compared using Fisher's exact test. Ordinal data were compared using the chi-squared test for trend. Multivariable binary logistic regression analysis was used to examine the relation between preeclampsia and metabolic syndrome with adjustment for the effect of potential confounding factors. Two-sided P-values <0.05 were considered statistically significant.

RESULTS

Table (1): Demographic characteristics and parity in cases of preeclampsia and controls

Variable		PE (n=300)		Control (n=300)		χ^2 (df,1)	P-value*
		n	%	n	%		
Age	18-29 years	181	60.3%	147	49.0%	1.701	0.192
	30-39 years	85	28.3%	132	44.0%		
	40-49 years	34	11.3%	21	7.0%		
Body mass index	<30 kg/m ²	90	30.0%	51	17.0%	5.289	0.021
	30-34.9 kg/m ²	91	30.3%	119	39.7%		
	35-39.9 kg/m ²	89	29.7%	97	32.3%		
	≥40 kg/m ²	30	10.0%	33	11.0%		
Parity	P0	157	52.3%	201	67.0%	1.381	0.280
	P1-P4	112	37.3%	45	15.0%		
	>P4	31	10.3%	54	18.0%		

Data are number (n) and percentage (%).

χ^2 = Chi-squared statistic, df = degree of freedom.

*Chi-squared test for trend.

Table (1) shows that after adjustment for other factors, age, BMI, parity were independent factors, for pre-eclampsia P value were 0.192, 0.021, 0.280 respectively.

Table (2): Grading of blood pressure and albuminuria in cases of preeclampsia (PE) and controls

Variable		PE (n=300)		Control (n=300)		$\chi^2(df,1)$	P-value*
		n	%	n	%		
Blood pressure	<130/90 mmHg	0	0.0%	300	100.0%	445.767	<0.001
	>130/90 mmHg to <140/100 mmHg	150	50.0%	0	0.0%		
	≥140/100 mmHg to <160/100 mmHg	120	40.0%	0	0.0%		
	>160/100 mmHg	30	10.0%	0	0.0%		
Albuminuria	Nil	0	0.0%	300	100.0%	400.028	<0.001
	1+	179	59.7%	0	0.0%		
	2+	61	20.3%	0	0.0%		
	3+	60	20.0%	0	0.0%		

Data are number (n) and percentage (%).

χ^2 = Chi-squared statistic, df = degree of freedom.

*Chi-squared test for trend.

Table (2) shows that after adjusting for other variables, blood pressure was a dependent factor for pre-eclampsia $X^2(df,1)$ 445.767, P value < 0.001, albuminuria also was a dependent factor of PE $X^2 (df,1)$ 400.028 P value < 0.001).

Table (3): Results of blood glucose and lipid testing in cases of preeclampsia and controls

Criteria of metabolic syndrome		PE (n=300)		Control (n=300)		χ^2 (df,1)	P-value*
		n	%	n	%		
Blood glucose	<100 mg/dl	205	68.3%	268	89.3%	39.577	<0.001
	≥100 mg/dl	95	31.7%	32	10.7%		
High density lipoprotein	≥50 mg/dl	178	59.3%	211	70.3%	7.947	0.005
	<50 mg/dl	122	40.7%	89	29.7%		
Low density lipoprotein	<250 mg/dl	233	77.7%	283	94.3%	34.549	<0.001
	≥250 mg/dl	67	22.3%	17	5.7%		
Triglycerides	<250 mg/dl	109	36.3%	222	74.0%	85.902	<0.001
	≥250 mg/dl	191	63.7%	78	26.0%		

Data are number (n) and percentage (%).

χ^2 = Chi-squared statistic, df = degree of freedom.

*Chi-squared test for trend.

Table (3) shows that there is significant association between the blood glucose level and incidence of pre-eclampsia X^2 (df,1 39.577, p value < 0.001), good relation between low HDL and incidence of PE X^2 (df,1) 7.949, p value 0.005 also, high LDL and incidence of pre-eclampsia X^2 (df,1) 34.549, P value < 0.001, high TG and incidence of pre-eclampsia X^2 (df,1) 85.902, p value < 0.001).

Table (4): Number of metabolic syndrome criteria in cases of preeclampsia and controls

Variable		PE (n=300)		Control (n=300)		χ^2 (df,1)	P-value*
		n	%	n	%		
Number of metabolic syndrome criteria	<i>Nil</i>	0	0.0%	41	13.7%	177.266	<0.001
	<i>Single criterion</i>	64	21.3%	161	53.7%		
	<i>Two criteria</i>	36	12.0%	23	7.7%		
	<i>Three criteria</i>	34	11.3%	59	19.7%		
	<i>Four criteria</i>	150	50.0%	16	5.3%		
	<i>Five criteria</i>	16	5.3%	0	0.0%		

Data are number (n) and percentage (%).

χ^2 = Chi-squared statistic, df = degree of freedom.

*Chi-squared test for trend.

Table (4) shows significant association between the number of metabolic syndrome criteria in cases and controls. The more the number of criteria the high percentage of pre-eclampsia

Table (5): Proportion of patients ultimately diagnosed as having metabolic syndrome among cases of preeclampsia and controls

Variable		PE (n=300)		Control (n=300)		P-value*
		n	%	n	%	
Metabolic syndrome	<i>No metabolic syndrome (≤ 2 criteria)</i>	100	33.3%	225	75.0%	<0.001
	<i>Metabolic syndrome (≥ 3 criteria)</i>	200	66.7%	75	25.0%	

Data are number (n) and percentage (%).

*Fisher's exact test.

Table (5) shows the incidence of metabolic syndrome in pre-eclampsia (66.7%) patients and in control (25%) P value < 0.001.

DISCUSSION

Recently, the incidence of pre-eclampsia has increased, probably in part because of obesity. Similarly, obesity by BMI in the non pregnant state was associated with increased risk of developing pre-eclampsia (*Ananth et al., 2013*). In this study, we evaluated the association between pre-pregnancy factors and the development of pre-eclampsia, we found that metabolic syndrome in the non-pregnant state has associated with an increased risk. Moreover, the incidence increased when the number of components of metabolic syndrome increased. The interpregnancy metabolic syndrome reportedly also predisposes to recurrent pre-eclampsia, although the time of onset of metabolic syndrome is unknown (*Stekking et al., 2013*). Although the clinical findings of PE are first noted during pregnancy, the underpinnings of the condition may originate prior to pregnancy (*Wen et al., 2012*).

Cho et al. (2016) evaluate the association between pre-pregnancy factors and development of PE. They found that MS in the pregnant state was associated with an increased risk. Moreover, the incidence of PE rose when the number of components of MS increased. Management strategies for MS including life style intervention, lower the risk of long-term cardiovascular disease (CVD) (*Wong, 2005; Deen, 2004*).

Dietary and lifestyle intervention, has been also known to reduce the risk of PE (Allen *et al.*, 2014). In this study, the prevalence of MS was lower than that in previous studies (Park and Kim, 2015). This may attributed to the exclusion of women with hypertension in non pregnant state n=2.697. The lower incidence may be also due to the characteristics of the other study population which consisted of a younger age group (Mean age 30.44± 3.27 years). Moreover in this study only 36% of the population had ≥ 1 cardiovascular risk factor among the component of MS i.e., obesity and BMI and a family history of hypertension. This is lower than the result of another study which reported that $\leq 60\%$ of reproductive aged women have ≥ 1 cardiovascular risk factor (Davignus *et al.*, 2004).

The cause of PE is unknown but previous studies found an association of elevated BMI and PE (Rudra and Williams, 2005). Women with low BMI have lower risk of PE than women at normal or higher BMI (Belghiti *et al.*, 2011).

The mechanism by which obesity increases the incidence of PE could include insulin resistance or inflammation (McDonald *et al.*, 2013). Insulin resistance has been associated with endothelial dysfunction (Valerio *et al.*, 2011), and increased secretion of endothelin 1 a potent vasoconstrictor. In addition, insulin resistance results in reduction of nitric oxide, increasing the risk of hypertension and CVD (Menzies *et al.*, 2007).

Kianpour *et al.* (2015) in their study found that the mean fasting blood sugar, triglyceride level and HDL level of the participants in weeks 20 and 30

of pregnancy in women with metabolic syndrome and healthy women they found that fasting blood sugar (FBS) and triglyceride level in the two groups were significantly different ($P < 0.001$) but the amount of HDL was not significant. The relative frequency of PE in pregnant women with MS and healthy subjects was significantly different ($P < 0.001$). The frequency of PE before 30 ws based on Fisher's exact test in women with MS has 8.2% and in healthy group was 1.2% after 30 ws of pregnancy based on Chi-square test, the frequency of PE in women of MS was 37.7% and in healthy group was 10.6%.

The relation between the items of MS and PE was studied. Based on the findings, it was observed that relative frequency of PE in pregnant women with MS and the control group was significantly different ($P < 0.001$). This agreed with *Lorenzo et al. (2003)* in their study showed that women with MS compared to the healthy group had significantly more blood disorder ($P < 0.001$) 31% increased pregnancy hypertension, and 46% PE in patients with MS.

In the present study 40.7% of the cases with PE had low HDL (< 50 mg/dl) while 29.7% of the control group has low HDL $X^2(df,1) 7.947$, $P = 0.005$. This result disagrees with *Lorenzo et al. (2003)* who said that there is no significant difference between the two groups. Also, in the present study 31.7% of the cases are with fasting blood glucose more than 100 mg/dl while 10.7% of the control group had higher FBG $X^2(df,1) 39.577$, $P < 0.001$. Also

63.7% of the cases with PE had high TG ≥ 250 mg/dl while 26% of the control had high TG $X^2(df,1)$ 85.902, $P < 0.001$. Also these results agree with *Lorenzo et al. (2003)*.

Regarding the BMI group was found that 70% of the cases of PE are BMI ≥ 30 kg/m² while 83% of the control has BMI ≥ 30 kg/m² $X^2(df,1)$ 5.289 $P = 0.021$. So there is insignificant difference in the 2 groups regarding BMI. This is disagree with *Dane et al. (2009)* who said that body mass index were significantly difference between the 2 groups of pregnant women with PE and healthy women ($P < 0.01$). Our study agree with *Rubbin Azize et al. (2007)* who said that serum TG in women with PE were higher than in control group ($P < 0.001$). Regarding the level of HDL cholesterol, in our study there was no significant difference between the cases and control group while *Rubbin Azize et al. (2007)* said that the mean HDL cholesterol in women with PE was lower in control group.

Gratacos et al. (2009) study the levels of TG and LDL in severe PE and control groups, their results showed significant difference in the mean levels of these variables between the two groups ($P < 0.001$). In their study, TG level in the PE group was 198.76 while in control group was 167 and LDL level in PE group was 309 while in control group was 217. These results were consistent with those of our study.

The risk of severe PE increased when BMI is the highest, also, *Akhavan et al. (2009)* revealed the relationship between hyperlipidemia and severity of PE severe PE showed an elevation of plasma TG, cholesterol and LDL.

Cholesterol concentration when compared to control group which are in agreement of current study. While *Baker et al. (2009)* disagreed so that he said that women with the most severe form of PE has TG level similar to normotensive controls

After a systemic evaluation of the results of these studies. It can be found whether these indicators are suitable markers for predicting PE or not. *Lorenzo et al. (2003)* *Rubbin Azize et al. (2007)*, *Gratacose et al. (2009)* believe that dyslipidemia associated with PE can occur due to endothelial dysfunction accumulation of cholesterol and TG in patient can even damage the endothelial function. *Solomon and Seeley (2011)* suggested that insulin resistance might involved in pathogenesis of prepregnancy hypertension. *Lei et al. (2016)* in their study the mean age of the pregnant women presented in the study was 29.07 ± 5.04 years 56.95% of them were primiparous women.

Stuebe et al. (2012) and *Ovesen et al. (2011)* said that elevated pre BMI and maternal obesity have been linked to a variety of pregnancy complication such as gestational diabetes mellitus (GDM) and PE. *Wiznitzer et al. (2009)* proved that lipid levels changed substantially during gestation, and abnormal levels of TG were associated with pregnancy complications. *Bartha et al. (2008)* found that metabolic syndrome was presented in about one third of women with pregnancy induced hypertension and in 10% of with late onset gestational diabetes. *Chatzi et al. (2009)* study showed that women with metabolic syndrome found in early pregnancy were at high risk of GDM (RR

= 3.17: 95% CI). *Baliutaviciene et al. (2012)* Pointed out that metabolic syndrome can be diagnosed not only before or after pregnancy but also during pregnancy.

Salzer et al. (2015) revealed that insulin resistance and hyperinsulinemia may be the basic common ground for MS of pregnancy. Moreover, MS is also associated with endothelial dysfunction oxidative stress, attenuated inflammatory response, maternal ability to adapt to these physiological changes can expose underlying previously silent cardiac pathology which is why some call pregnancy nature's stress test. *Alberti et al. (2009)* suggest that MS is a complex of interrelated risk factors for CVD and diabetes. These factors include hyperglycaemia raised BP elevated TG, low HDL and obesity.

The current study is consistent with *Smith et al. (2009)*, *Stekking et al. (2009)*, *Lu et al. (2011)* they said that the prevalence of MS components in PE women was high in their study subjects. Also our findings are in agreement with the study of *Smith et al. (2009)* who showed a higher prevalence of metabolic syndrome among women with PE compared to healthy pregnant women. *Dane et al. (2009)*, *Mazar et al. (2007)* revealed that metabolic score during pregnancy has a role in predicting of PE.

Many studies indicated that overweight causes insulin resistance. *Belfort et al. (2005)* elevate inflammatory markers and risk of developing CVD. *Driul et al. (2008)* reported that obese women were time more probably to develop PE. It has also indicated that there is an association between Choi

intolerance, hypertriglyceridemia and low HDL with the development of PE (Ray *et al.*, 2006).

Rafeinia *et al.* (2014) in their study showed that dyslipidemia is an important risk factor for PE in overweight pregnant women which is in agreement with the present study and the finding of other studies showing that women who develop PE have higher TG, cholesterol and LDL and lower HDL cholesterol concentration than healthy pregnant women.

Several studies have shown the association between pre-pregnancy overweight and metabolic pathways dysregulation during pregnancy (Lopez-Jaramilo, 2009). The serum lipids increased in women with PE.

The pathogenesis of PE may be dependant on lipid synthesis alteration and lipid metabolism abnormality (Baksu *et al.*, 2005). Many studies have been shown the association of high TG and LDL cholesterol with pathogenesis of PE. Some other studies have demonstrated the association between lipid level and severity of PE (Belogolovkin *et al.*, 2007).

CONCLUSION

There is a significant relation between the incidence of PE and presence of metabolic syndrome and the more number of items of metabolic syndrome the high risk of occurrence of PE.

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ارتباط متلازمة الأيض وحدوث تسمم الحمل لدى السيدات

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المستخلص

يعد تسمم الحمل أحد المضاعفات التي تحدث للحوامل بعد مرور ٢٠ أسبوع من الحمل فنسبة حدوثها تتراوح بين ٣٠% إلى ٥٠% من مجمل حالات الحمل في العالم. لقد وجدت الدراسات أن النساء المصابات بتسمم الحمل يرتفع لديهم معدل خطر الإصابة بأمراض القلب وأمراض الجهاز العصبي والأوردة الطرفية بمعدل الضعف ولقد وجد أن هناك عدة عوامل خطورة مثل: مرض السكري، والسمنة، وضغط الدم المرتفع، وأمراض القلب - تلك العوامل تزيد في حالات تسمم الحمل. يعرف متلازمة الأيض بأنه مجموعة من العيوب مثل تزايد الدهون بالدم، السمنة، مقاومة الأنسولين وارتفاع السكر في الدم، إكتشاف هذه المتلازمة قد يقينا من حدوث مضاعفات الحمل. لقد وجدت هذه المضاعفات بين السيدات المصابات بتسمم الحمل أكثر من غيرهن من الحوامل. أثبتت الدراسات أن النساء المصابات بمتلازمة الأيض هن أكثر عرضة لأمراض القلب والأوعية الدموية والوفاة بسببها كذلك تسبب تعد السمنة عاملاً هاماً لحدوث مشاكل في وظيفة المشيمة وبالتالي حدوث تسمم الحمل. **الهدف من الدراسة:** بيان العلاقة بين متلازمة الأيض وحدث تسمم الحمل لدى السيدات الحوامل كذلك لتقييم استخدام مقياس متلازمة الأيض في تحديد تطور وشدة حالات تسمم الحمل.

طريقة الدراسة: نوع الدراسة: دراسة مقارنة

وقد تم إختيار المشاركات في الدراسة من مستشفى بولاق الدكرور العام اللائي حضرن الي المستشفى لحالة ولادة على مدى ٢٤ شهر بدءاً من يناير ٢٠١٧ حتى ديسمبر ٢٠١٨. تحتوى هذه الدراسة على ٦٠٠ مشتركة مقسمات الي مجموعتين، المجموعة الاولى: مكونة من ٣٠٠ مشتركة مصابات بتسمم الحمل بينما المجموعة الثانية: مكونة من ٣٠٠ مشتركة من الحوامل الغير مصابات بتسمم الحمل.

الخلاصة: أظهرت النتائج الإحصائية للدراسة أنه هناك علاقة ذات دلالة إحصائية بين متلازمة الايض والاصابة بتسمم الحمل. وكلما زادت مفردات متلازمة الايض كلما زاد تعرض المريضة بالاصابة بتسمم الحمل.
كلمات دالة: متلازمة الايض - تسمم الحمل