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ORIGINAL RESEARCH

Metabolic Syndrome During Pregnancy: Prevalence and Determinants Among Pregnant Women Followed-Up at the Dschang District Hospital, West Region of Cameroon

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Purpose: Metabolic syndrome (MS) during pregnancy constitutes a serious threat to the mother and child health that will shortly become a major public health issue, especially in developing countries. However, in Cameroon, epidemiological data on MS during pregnancy are still scarce. The aim of this study was to determine the prevalence and determinants of MS among pregnant women followed-up at the Dschang District Hospital (DDH), in the west region of Cameroon.

Patients and Methods: This study was a hospital based cross-sectional study, carried out among pregnant women followed-up at the antenatal care unit of the DDH, from September 2019 to June 2020. Participants were assessed on sociodemographic, lifestyle parameters, and dietary habits using standardized and structured questionnaires. Anthropometric parameters, blood pressure, and biochemical markers were measured using standard procedures. Metabolic syndrome was diagnosed using the HNLBI/AHA definition, modified for pregnant women by Chatzi et al. A participant was recorded as having MS if presenting at least three of the following criteria: Pre-gestational BMI >30 kg/m2; triglycerides ≥150 mg/dl; HDL cholesterol <50 mg/dl; SBP ≥130/DBP ≥85 mm/Hg; and fasting blood glucose ≥100 mg/dl.

Results: Six hundred and four (604) pregnant women were included in the study. The prevalence of MS was 17.88% (95% CI: 15.03–21.14) and its most frequent individual components were low levels of HDL-cholesterol (66.23% (95% CI: 62.36–69.88)) and hypertriglyceridemia (28% (95% CI: 54.31–62.15)). Grand multiparous shows a higher risk of presenting MS (OR:3.06, 95% CI: 1.24–7.12; p = 0.011) compared to nulliparous. Pregestational BMI appears to be the best predictor of MS during pregnancy even after adjustment on age, parity, lifestyle and dietary habits (OR: 46.46, 95% CI: 15.58–138.49; $p < 0.0001$).

Conclusion: The prevalence of MS on pregnant women in the Dschang health district is 17.88% (95% CI: 15.03–21.14) and its major determinant is pre-gestational obesity. This work provides quality preliminary data for the design and improvement of prevention strategies.

Keywords: metabolic syndrome, pregnancy, risk factors, Dschang health district

Introduction

Metabolic syndrome (MS) is a complex set of interconnected cardiovascular diseases and type II diabetes risk factors that occur more often together than by chance alone.[1] Metabolic abnormalities related to MS include obesity, impaired glucose tolerance, dyslipidemia and elevated blood pressure, all related to chronic low-grade inflammation and alterations of insulin sensitivity.[2] MS is a common and serious health issue, both in developed and developing countries. Its prevalence is reaching astounding proportions all around the world. About one third of US adults have MS.[2] Its prevalence varies from 20.41% to 39.68% in China and from 24% to 33% in India.[3,4] Comparable tendency is observed in Africa, with a prevalence of MS varying across countries and depending on the diagnosis criteria considered. Authors

reported a prevalence of 34.6% in Kenya, 19.1% in Uganda, 34.89% in Ethiopia, 42.6% in South Africa.[5–8] In Cameroon, the prevalence of MS is reported to be 32.45% in the west region of the country, based on the IDF criteria.[9]

The relatively high prevalence of MS observed in Africa and especially in Cameroon shows a strong predominance among females. Indeed, women seem to be more affected by MS and its components than men, regardless of age and other risk factors.[5,7–9] Determinants of that feminine predominance of MS may include socio-cultural parameters, metabolic variations related to the reproductive cycle and multiple pregnancies.[5,10] When occurs during pregnancy, MS constitutes a serious threat to the mother and child's health.[10] Few studies have highlighted a link between MS in early pregnancy or its individual features and adverse maternal and fetal pregnancy but also perinatal outcomes, including gestational diabetes, preterm birth, neural tube defects and increase risk for the newborn to develop obesity, MS or type 2 diabetes later in life.[11–14] The consequences of MS during pregnancy thus affect not only the pregnant mother but also the child to be born. MS during pregnancy therefore has to become a special concern to be addressed, in other to prevent maternal and fetal complications, as well as a future expansion of its incidence. However, there is still not a consensus on the definition of MS during pregnancy, for the metabolic changes that occur all along normal pregnancy overlap MS related disorders.[13,15] Existing definitions with cut-off points adapted to pregnancy are available and may be used for diagnosis purpose, but in a preventive perspective, a set of criteria with higher sensitivity may be necessary.[13,15] In Cameroon, as in many developing countries, there are still low epidemiological data on MS during pregnancy, with a lack of information on its determinants and potential targets for efficient prevention strategies. Better attention on the diagnosis of MS during pregnancy could help identify phenotypes of women presenting higher risk of adverse pregnancy outcomes and cardio metabolic conditions later in life, but also newborns with predispositions to childhood obesity and MS.[11,15]

The aim of this study, thus, is to determine the prevalence and determinants of MS among pregnant women of the Dschang health district in the west region of Cameroon.

Materials and Methods
Ethical Considerations
The study received approval from the Dschang health district and Dschang district hospital authorities. The "Cameroon Bioethics Initiative Ethics Review and Consultancy Committee (CAMBIN/ERCC)" approved the study protocol with a research ethical clearance at the number CBI/471/ERCC/CAMBIN. Each step of the study was realized in accordance with the Helsinki declaration, and all participants provided signed informed consent.

Study Design
This study was a hospital based cross-sectional study, conducted from September 2019 to June 2020, among pregnant women attending antenatal care at the Dschang District Hospital (DDH), in the Dschang Health District (DHD), west region of Cameroon.

Sample Size and Sampling Method
The sample size was calculated using the Statcalc tool of the software Épi info version 7.2.3.1, assuming an estimated prevalence of MS of 7.39% in the DDH,[16] a 5% acceptable margin of error, an estimated design effect of 5 and a 95% confidence level. The minimum sample size was thus of 520 participants. A percentage of imponderables of 10% was added to the model for a final minimal sample size of 572 participants. Selection of participants was made by exhaustive sampling of all the pregnant women meeting selection criteria.

Participants
We included in the study, apparently healthy Cameroonian pregnant women aged from 16 to 45 years of any pregnancy age, coming for antenatal consultation at the DDH. Pregnant women with recorded diabetes mellitus, cardiovascular diseases (For, the definition of MS during pregnancy considered in the study is not applicable for pregnant women with previously diagnosed diabetes mellitus or cardiovascular diseases.) and mental illness were not included in the study. Participants with multiple pregnancies detected after the first ultrasound scan were excluded from the study sample.

Administration of the Questionnaire

The study questionnaire was organized in three different parts: A survey form inspired from the WHO STEPS instrument for chronic diseases surveillance, recording personal and family history of chronic diseases as well as alcohol and tobacco use; A modified version of the Ricci and Gagnon questionnaire evaluating participants' level of physical activity and a food frequency questionnaire, recording dietary habits of participants. Individual questionnaires were filled by each participant, through a face-to-face interview with the principal investigator.

Determination of Anthropometric Parameters

Height was measured with a height gauge to the nearest 0.1 cm. Weight was measured using a scale (SECA®) to the nearest 0.1 kg. Pre-pregnancy weight was collected when available from medical records or self-reported by participants. Body Mass Index (BMI) was calculated using the Quételet's formula: $BMI = Weight (kg)/Height^2 (m)$ and expressed as kg/m^2. A $BMI \geq 25$ defined overweight and a $BMI \geq 30$ defined obesity.[17]

Blood Pressure Measurement

Blood pressure (BP) was measured with an Automatic Blood Pressure Monitor with Heart Sense (One Plus Healthcare® FT-11B) in a sitting position after at least 10 minutes of rest and two measurements were taken after 5 minutes intervals. The average of the two measurements was used to assess blood pressure level.

Blood Sampling

A sample of 5 mL of blood was collected on dry tubes by venipuncture on the antecubital fossa from each participant after overnight fasting. The serum was obtained by centrifugation at 3500 g during 5 minutes and aliquots were frozen at −20°C previous to biochemical analyses.

Biochemical Analyses

Fasting blood glucose was directly measured by reflectometry on capillary blood (collected at the participant's fingertip) using a glucometer (OnCall Sharp®) and glucose test tips. The concentration of serum total cholesterol, HDL-cholesterol and triglycerides were measured by the standard enzymatic spectrophotometric method,[18,19] using Labkit® Diagnostic kits. LDL-cholesterol concentrations were assessed using Friedewald's formula for triglycerides levels lower than 350 mg/dl.[20] Atherogenicity index was defined as the ratio Total cholesterol/HDL-cholesterol. All specimens and reagents were handled according to the manufacturer instructions.

Diagnosis of Metabolic Syndrome

Metabolic syndrome was diagnosed using the HNLBI/AHA and NECP ATP III definitions, modified for pregnant women by Chatzi et al[12,13] A participant was recorded as having MS if presenting at least three of the following criteria: Pre-gestational BMI >30 kg/m2; triglycerides ≥150 mg/dl; HDL cholesterol <50 mg/dl; SBP ≥130/DBP ≥85 mm/Hg; and fasting blood glucose ≥100 mg/dl.

Statistical Analyses

Data treatment was performed using the softwares Epi info™ 7.2.3.1 for Microsoft Windows® and R.4.0.2 for Microsoft Windows®. For descriptive statistics, categorical variables are presented as frequency distribution tables and continuous variables as mean ± standard deviation (SD). The comparison of MS prevalence among potential determinants was performed using the Pearson Chi-squared test and means of biological parameters were compared among participants with MS and participants without MS using the Student's t-test. Generalized linear models (binary logistic regression) were performed to predict MS and identify its determinants. The level of significance for all inferential statistics was set at $p < 0.05$.

Results

A total of 621 pregnant women were included in the study. After verification of exclusion criteria, a final sample of 604 pregnant women was considered. Their sociodemographic and obstetric characteristics are summarized in Table 1. The

Table I Sociodemographic and Obstetric Characteristics of the Study Population

Parameter		Frequency in % (n)
Age (Years)		Mean ± SD: 26.75 ± 5.57
	< 20	6.95 (42)
	[20–30]	61.75 (373)
	[30–40]	28.97 (175)
	≥ 40	2.32 (14)
Marital status	Single	35.43 (214)
	Divorced	0.66 (4)
	Cohabitation	8.61 (52)
	Married	55.30 (334)
Level of education	No formal education	2.32 (14)
	Primary	6.13 (37)
	Secondary	45.36 (274)
	Higher education	46.19 (279)
Stage of the pregnancy		Mean ± SD: 22.78 ± 9.20 (weeks)
	1st Trimester	25.83 (156)
	2nd Trimester	42.22 (255)
	3rd Trimester	31.95 (193)
Parity	Nulliparous	50.09 (276)
	Primiparous	19.42 (107)
	Multiparous	25.41 (140)
	Grand multiparous	5.08 (28)

Abbreviations: (n), Absolute frequencies; SD, Standard deviation.

mean age was 26.75 ± 5.57 and 61.75% of participants were aged between 20–30 years. Most participants were married (55.30%) with secondary (45.36%) or higher (46.19%) education level achieved. The mean gestational age was 22.78 ± 9.20 weeks and half of the study population (50.09%) comprised nulliparous pregnant women. Concerning Pre-gestational BMI, 29.80% (180) had a normal BMI and 42.88% (259) were overweight before pregnancy.

Table 2 shows the prevalence of metabolic syndrome and its individual components in the study population. One hundred and height pregnant women were diagnosed positive to metabolic syndrome for a prevalence of 17.88% (95% CI: 15.03–21.14). The most frequent individual component of MS was low levels of HDL-cholesterol, with a prevalence of 66.23% (95% CI: 62.36–69.88), followed by hypertriglyceridemia with a prevalence of 58.28% (95% CI: 54.31–62.15). A multivariate binary logistic regression model was performed to identify predictors of MS among its individual components. The results presented in Table 2 indicate that pre-gestational BMI (OR: 1.36, 95% CI: 1.28–1.46; $p < 0.0001$) and HDL-cholesterol blood level (OR: 0.96, 95% CI: 0.94–0.98; $p < 0.0001$), are the key components of MS during pregnancy.

Table 2 Prevalence of MS and Its Individual Components and Multivariate Logistic Regression Model to Predict MS by Its Individual Components

Prevalence			Multivariate Logistic Regression Model		
Components	Prevalence (%)	95% CI	**Components**	OR (95% CI)	p
Pre-pregnancy obesity	27.32	23.92–31.01	**Pre-pregnancy BMI**	1.36 (1.28–1.46)	< 0.0001
Elevated blood pressure	11.92	9.57–14.75	**SBP**	1 (0.99–1.01)	0.658
High fasting blood glucose	4.97	3.50–7.00	**DBP**	1.04 (1.01–1.07)	0.001
Hypertriglyceridemia	58.28	54.31–62.15	**Blood glucose level**	1.02 (1.00–1.05)	0.025
Low HDL-cholesterol	66.23	62.36–69.88	**Triglycerides**	1 (1.00–1.01)	< 0.0001
Metabolic syndrome	17.88	15.03–21.14	**HDL-cholesterol**	0.96 (0.94–0.98)	< 0.0001

Abbreviations: OR, Odd ratio; CI, Confidence interval; SBP, Systolic blood pressure; DBP, Diastolic blood pressure.

The cardio metabolic profile of pregnant women included in this study is shown in Table 3. The mean values of pre-gestational Body Mass Index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), blood glucose level, triglycerides, HDL-cholesterol level and atherogenicity index were significantly higher in pregnant women with MS compared to healthy ones.

Table 4 presents the comparison of MS prevalence according to sociodemographic and obstetric parameters. It shows an increase in the prevalence of MS with age of participants. Indeed, the prevalence of MS was 4.76% among participants aged under 20 years old, 14.48% among participants aged between 20–30 years old, 25.71% among participants aged 30–40 years old and 50% among participants aged 40 years old and above ($p < 0.0001$). Besides,

Table 3 Metabolic Profile of Study Participants

Parameters	General (604)	Non-MS (496)	MS (108)	p
Pre-pregnancy BMI	27.92 ± 4.83	26.80 ± 4.09	33.04 ± 4.68	< 0.0001
SBP	111.40 ± 42.90	110.50 ± 46.84	115.58 ± 14.15	0.043
DBP	71.66 ± 9.86	70.74 ± 9.61	75.87 ± 9.96	< 0.0001
Blood glucose	78.88 ± 11.90	78.16 ± 10.44	82.18 ± 17.05	0.020
TG	194.16 ± 109.28	181.05 ± 103.86	254.39 ± 113.74	< 0.0001
TC	195.52 ± 83.11	196.26 ± 84.23	192.15 ± 78.07	0.626
HDL-C	50.40 ± 34.96	53.27 ± 36.55	37.21 ± 22.17	< 0.0001
LDL-C	117.19 ± 79.70	117.84 ± 80.82	114.08 ± 74.36	0.660
Atherogenicity index	5.14 ± 3.78	4.94 ± 3.77	6.03 ± 3.10	0.001

Note: Data are presented as mean ± standard deviation.
Abbreviations: MS, Metabolic syndrome; BMI, Body mass index; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; TG, Triglycerides; TC, Total cholesterol; HDL-C, High density lipoprotein cholesterol; LDL-C, Low density lipoprotein cholesterol.

Table 4 Comparison of MS Prevalence According to Sociodemographic and Obstetric Parameters

Parameters		Non-MS (496)	MS (108)	p
Age	< 20	95.24 (40)	4.76 (2)	< 0.0001
	[20–30]	85.52 (319)	14.48 (54)	
	[30–40]	74.29 (130)	25.71 (45)	
	≥ 40	50.00 (7)	50.00 (7)	
Stage of the pregnancy	1st Trimester	87.18 (136)	12.82 (20)	0.154
	2nd Trimester	80.78 (206)	19.82 (49)	
	3rd Trimester	79.79 (154)	20.21 (39)	
Marital status	Single	87.38 (187)	12.62 (27)	0.036
	Divorced	100.00 (4)	0.00 (0)	
	Cohabitation	82.62 (44)	15.38 (8)	
	Married	78.14 (261)	21.86 (73)	
Level of education	None	92.86 (13)	7.14 (1)	0.709
	Primary	78.38 (29)	21.62 (8)	
	Secondary	81.39 (223)	18.61 (51)	
	Higher education	82.80 (231)	17.20 (48)	
Parity	Nulliparous	86.59 (239)	13.41 (37)	0.019
	Primiparous	87.85 (94)	12.15 (13)	
	Multiparous	79.29 (111)	20.71 (29)	
	Grand multiparous	67.86 (19)	32.14 (9)	
Pre-pregnancy BMI	Normal weight	97.79 (177)	2.21 (4)	< 0.0001
	Overweight	93.44 (242)	6.56 (17)	
	Obese	46.95 (77)	53.05 (87)	

Note: Data are presented as relative frequencies (in %) and absolute frequencies (n).
Abbreviations: MS, Metabolic syndrome; BMI, Body mass index.

the prevalence of MS was higher among married participants (21.86%), grand multiparous (32.14%) and obese pregnant women (53.05%).

Influence of family history of chronic diseases, level of physical activity and lifestyle parameters on the prevalence of MS is shown in Table 5. There is no significant difference in the prevalence of MS according to family history of chronic diseases. Regarding lifestyle parameters and level of physical activity, there is a higher prevalence of MS among pregnant women consuming alcohol before or during pregnancy (20.89% and 25.19% respectively) compared to non-consumers (13.47% and 15.54% respectively). Besides, the prevalence of MS tends to decrease with an increase in the duration of daily walking practice even though the difference is not significant ($p = 0.058$).

Table 6 presents the comparison of the prevalence of MS according to dietary habits. It appears from this table that some dietary habits are associated with a higher prevalence of MS, those are eating close to bedtime (19.38%), regular consumption of soft drinks (21.62%) and regular consumption of eggs (19.71%). Participants eating fresh fruits over four days per week presented lower prevalence of MS (11.46%) than those eating fresh fruits only four days or fewer a week.

Table 7 shows the results of univariate and multivariate binary logistic regression models to predict MS according to relevant independent variables of the study. It indicates that pregnant women aged 30 years or above present higher risk of having MS compared to younger ones. Concerning parity, grand multiparous shows a higher risk of presenting MS (OR:3.06, 95% CI: 1.24–7.12; $p = 0.011$) compared to nulliparous. Overweight (OR: 3.11, 95% CI:1.13–10.94; $p = 0.045$) and obese (OR: 50.00, 95% CI: 19.97–167.85; $p < 0.0001$) participants also present a higher risk of developing MS compared to normal weight participants. The risk of developing MS also increases with alcohol consumption before pregnancy (OR:1.70, 95%

Table 5 Comparison of MS Prevalence According to Family History of Chronic Diseases, Level of Physical Activity and Lifestyle Parameters

Parameters		Non-MS (496)	MS (108)	p
Family history of chronic diseases				
Type 2 Diabetes	Yes	77.42 (96)	22.58 (28)	0.147
	No	83.33 (400)	16.67 (80)	
Cardiovascular diseases	Yes	76.25 (61)	23.75 (19)	0.159
	No	82.92 (432)	17.08 (89)	
Gestational diabetes	Yes	84.00 (21)	16.00 (4)	0.802
	No	82.04 (475)	17.96 (104)	
Pre eclampsia or eclampsia	Yes	85.71 (12)	14.29 (2)	0.716
	No	81.94 (481)	18.06 (106)	
Lifestyle and Level of physical activity				
Alcohol consumption before pregnancy	Yes	79.11 (284)	20.89 (75)	0.019
	No	86.53 (212)	13.47 (33)	
Alcohol consumption during pregnancy	Yes	74.83 (110)	25.17 (37)	0.008
	No	84.46 (386)	15.54 (71)	
Physical activity	Yes	81.25 (156)	18.75 (36)	0.703
	No	82.52 (340)	17.48 (72)	
Daily walking	< 30 minutes	80.26 (248)	19.74 (61)	0.058
	30–60 minutes	83.35 (210)	17.65 (45)	
	> 60 minutes	95.00 (38)	5.00 (2)	
Farm work	Yes	82.57 (251)	17.43 (53)	0.773
	No	81.67 (245)	18.33 (55)	
Physical activity level score	Inactive	82.76 (240)	17.24 (50)	0.632
	Active	81.17 (250)	18.33 (58)	
	Very active	100.00 (6)	0.00 (0)	

Note: Data are presented as relative frequencies (in %) and absolute frequencies (n).
Abbreviations: MS, Metabolic syndrome; BMI, Body mass index.

Table 6 Comparison of MS Prevalence According to Dietary Habits

Parameters		Non-MS (496)	MS (108)	p
Number of meals per day	1–2	82.84 (280)	17.16 (58)	0.878
	3–4	81.10 (206)	18.90 (48)	
	< 5	83.33 (10)	16.67 (2)	
Eating close to bedtime	Yes	80.62 (391)	19.38 (94)	0.031
	No	88.24 (105)	11.76 (14)	
Weekly consumption of soft drinks	Yes	78.38 (174)	21.62 (68)	0.043
	No	84.29 (331)	15.71 (65)	
Weekly consumption of Tea or coffee	Yes	79.33 (165)	20.67 (43)	0.194
	No	83.59 (4)	16.41 (0)	
Weekly consumption of Cakes, cookies, donuts	Yes	80.95 (340)	19.05 (80)	0.258
	No	84.78 (156)	15.22 (28)	
Consumption of Fresh fruits	< 4 days/week	80.91 (44)	19.09 (8)	0.045
	> 4 days/week	88.54 (261)	11.46 (73)	
Weekly consumption of Raw vegetables	Yes	82.33 (396)	17.67 (85)	0.790
	No	81.30 (100)	18.70 (23)	
Weekly consumption of cooked vegetables	Yes	80.91 (356)	19.09 (84)	0.203
	No	85.37 (140)	14.63 (24)	
Weekly consumption of Eggs	Yes	80.29 (334)	19.71 (82)	0.049
	No	86.17 (162)	13.83 (26)	

Note: Data are presented as relative frequencies (in%) and absolute frequencies (n).
Abbreviations: MS, Metabolic syndrome; BMI, Body mass index.

Table 7 Logistic Regression Models Predicting Metabolic Syndrome

Explanatory Variables		Univariate OR (95% CI)	p	Multivariate OR (95% CI)	p
Age	< 20	–	–	–	–
	[20–30]	3.39 (1.00–21.16)	0.099	1.37 (0.26–7.27)	0.710
	[30–40]	6.92 (2.01–43.57)	0.009	1.31 (0.22–7.81)	0.764
	≥ 40	20.00 (3.94–155.09)	0.001	2.11 (0.17–26.20)	0.562
Parity	Nulliparous	–	–	–	–
	Primiparous	0.89 (0.44–1.72)	0.743	0.53 (0.26–1.23)	0.136
	Multiparous	1.69 (0.98–2.88)	0.056	1.00 (0.47–2.14)	0.991
	Grand multiparous	3.06 (1.24–7.12)	0.011	0.94 (0.26–3.36)	0.927
Pre-pregnancy BMI	Normal weight	–	–	–	–
	Overweight	3.11 (1.13–10.94)	0.045	2.69 (0.86–8.44)	0.090
	Obese	50.00 (19.97–167.85)	< 0.0001	46.46 (15.58–138.49)	< 0.0001
Alcohol consumption before pregnancy	Yes	1.70 (1.09–2.68)	0.020	1.00 (0.50–1.94)	0.979
	No	–	–	–	–
Alcohol consumption during pregnancy	Yes	1.83 (1.16–2.86)	0.009	0.76 (0.36–1.56)	0.463
	No	–	–	–	–
Daily walking	< 30 minutes	–	–	–	–
	30–60 minutes	0.87 (0.57–1.33)	0.527	1.04 (0.58–1.87)	0.889
	> 60 minutes	0.21 (0.03–0.73)	0.037	0.24 (0.03–2.08)	0.195
Eating close to bedtime	Yes	1.80 (1.02–3.42)	0.055	1.85 (0.83–4.16)	0.133
	No	–	–	–	–
Weekly consumption of soft drinks	Yes	1.48 (0.97–2.26)	0.068	1.59 (0.88–2.88)	0.128
	No	–	–	–	–
Weekly Consumption of fresh fruits	< 4 days/week	–	–	–	–
	> 4 days/week	0.55 (0.27–1.03)	0.077	0.74 (0.31–1.77)	0.498
Weekly consumption Eggs	Yes	1.53 (0.96–2.51)	0.082	1.53 (0.78–2.98)	0.217
	No	–	–	–	-

Abbreviations: OR, Odd ratio; CI, Confidence interval.

CI: 1.09–2.68; p = 0.020) and alcohol consumption during pregnancy (OR:1.83, 95% CI: 1.16–2.86; p = 0.009), while it significantly decreases with at least 60 minutes of daily walking (OR: 0.21, 95% CI: 0.03–0.73; p = 0.037).

Discussion

The present study aimed to determine the prevalence of Metabolic Syndrome and associated factors among pregnant women in the Dschang health district in the west region of Cameroon. The prevalence of MS in the study population was 17.88% (95% CI: 15.03–21.14). Similar result was obtained by Grieger et al among nulliparous pregnant women recruited in the UK, New Zealand and Australia, but lower prevalence was obtained by Djeufouata et al in the littoral and center regions of Cameroon.[21,22] The relatively high prevalence of MS observed in the present study, can be attributed to the definition criteria that vary from one study to another, but also to a higher prevalence of pre-gestational obesity in our study which appears to be the major determinant of MS during pregnancy.[22] Indeed, our study took place in the west region of Cameroon, where the prevalence of obesity is among the highest in the country, and overweight considered as a sign of wellbeing.[9]

Among individual components of MS, low levels of HDL-cholesterol (66.23%; 95% CI: 62.36–69.88) and hypertri-glyceridemia (58.28%; 95% CI: 54.31–62.15) were the most frequent in the study population. Pinto et al found a strong association between MS and HDL-cholesterol levels even after adjustment on other parameters, suggesting a tight relation-ship between low HDL-cholesterol blood levels and the physiopathology of MS during pregnancy.[23] Grieger et al,[21] in their study in Australia, also found hypertriglyceridemia to be the most common component of MS among pregnant women. This predominance of hypertriglyceridemia and low levels of HDL-cholesterol may be the consequence of impaired insulin sensitivity related modifications in triglycerides metabolism. Indeed, the amount of circulating triglycerides increases with gestational age, transported through lipoproteins.[24,25] Authors have reported that an enrichment of HDL with triglycerides was associated with a greater clearance of HDL, leading to low levels of HDL-cholesterol.[26]

The comparison of our study participants' metabolic profile shows a significant increase of pre-gestational BMI, SBP, DBP, triglycerides, blood glucose levels, atherogenicity index and a significant decrease of HDL-cholesterol in pregnant women with MS compared to healthy ones (Table 3). These results are similar to those of dos Prazeres et al and Djeufouata et al[22,27] and paint a picture of a MS related degradation of pregnant women's metabolism with alteration of different metabolic pathways mostly driven by impaired insulin sensitivity.[28]

The comparison of MS prevalence according to sociodemographic and obstetric parameters shows a significant increase of the prevalence of MS with age of participants. There is a higher prevalence of MS among married participants compared to participants with other marital status; the prevalence of MS is also higher among multiparous and grand multiparous compared with pauciparous (Table 4). Associations between age, parity and MS are strengthened by the results of univariate binary logistic regression which showed that pregnant women aged 30 years or above present higher risk of having MS compared to younger ones (Table 7) and grand multiparous shows higher risk of developing MS (OR: 3.06, 95% CI: 1.24 −7.12; p = 0.011) compared to nulliparous. These results draw nigh to the results of dos Prazeres et al who found significant associations between age, parity and MS in Angolan pregnant women.[27] Age is a well-known risk factor for an extensive set of chronic diseases, including obesity and metabolic syndrome.[2] Besides, several authors have shown that multiparous women have higher risk of developing metabolic syndrome; this may be associated with the proven correlation between multiparity and the development of abdominal obesity that leads to adipose tissue mediated dysregulation of insulin sensitivity and other metabolic pathways.[29–31]

In this study, we found no significant association between the prevalence of MS and family history of chronic diseases (Table 5). This result is consistent with the review of Saklayen, presenting evidence that genetic predisposition may play minor role in the development of MS despite the existence of some genes associated to obesity and MS. On the contrary, epigenetics may have a bigger role promoting MS.[2]

Regarding lifestyle parameters and level of physical activity, there is higher prevalence of MS among pregnant women consuming alcohol before or during pregnancy while the prevalence tends to decrease with an increase in the duration of daily walking practice (Table 5). These results are confirmed by the logistic regression. Indeed, the risk of developing MS increases with alcohol consumption before pregnancy (OR:1.70, 95% CI: 1.09–2.68; p = 0.020) and alcohol consumption during pregnancy (OR:1.83, 95% CI: 1.16–2.86; p = 0.009), while it significantly decreases with at

least 60 minutes of daily walking (OR: 0.21, 95% CI: 0.03–0.73; p = 0.037). Previous studies have reported an association between alcohol consumption and MS on various subpopulations, including pregnant women.[32,33] Even though the role of alcohol consumption in triggering the development of MS remains controversial, evidences suggest that moderate to high alcohol consumption levels lead to hypertriglyceridemia, inhibition of lipid oxidation in adipose tissue and fat storage.[34,35]

Concerning physical activity, our results suggest that moderate but consistent daily effort may lower the risk of developing MS on pregnant women. This is not in accordance with previous study that reported inverse association between MS and vigorous but not low and moderate exercise.[22] Nonetheless, there are evidences that chronic exercise presents benefits on MS by promoting energy balance, but also by triggering healthy physiological modifications in muscles cells and tissues.[2]

It appears from this study that some dietary habits including eating close to bedtime, regular consumption of soft drinks and regular consumption of eggs are associated with a higher prevalence of MS, while eating fresh fruits over four days per week is associated with a lower prevalence of MS (Table 6). These results add supporting evidence of nutritional transition in Cameroonian populations with progressive abandon of traditional dietary habits to westernized diet and lifestyle with consequences on metabolic health, as previously reported.[32,33]

Binary logistic regression models were performed in this study, to identify predictors of MS among its individual components and relevant independent variables (Tables 2 and 7). Pre-gestational obesity appears as the best predictor of MS during pregnancy even after adjustment on age, parity, lifestyle and dietary habits. Indeed, pre-gestational BMI have been previously reported as the major component of MS during pregnancy.[22,23] Pre-gestational obesity may contribute to a worsening of metabolic profile alteration on pregnant women, leading to a higher risk of developing MS.

Strength and Limitations

This study is among the first to address the prevalence and factors associated with MS during pregnancy in the west region of Cameroon and provide quality preliminary data for the design and improvement of prevention strategies. Moreover, The Dschang District Hospital is the major health facility in the Dschang health district and that guarantee a good representativity of the study sample. However, there is no standardized definition of MS for pregnant women and the definition considered in this study may leads to an overestimation of its prevalence. Besides, some of the findings may be subjected to measure bias due to self-reported information that may be altered by recall bias.

Conclusion

The prevalence of MS on pregnant women in the Dschang health district is 17.88% (95% CI: 15.03–21.14) majorly determined by pregestational obesity. Interventions then needs to targets women of reproductive age. This work provides a valuable starting point for further studies in the region and the country, for the setting of dietary and clinical recommendations that may contribute to a better prevention of MS during pregnancy as well as its maternal and perinatal adverse outcomes.

Abbreviations

HNLBI/AHA, National Heart, Lung and Blood Institute/American Heart Association; NCEP ATP III, National Cholesterol Education Program, Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults; HDL-C, High-density lipoprotein cholesterol; MS, Metabolic syndrome; TG, Triglyceride.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Disclosure

The authors report no conflicts of interest in this work.

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