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Research Article

Correlation Between Pregravid Nutritional Status, Obstetric Nutritional Risk and Maternal Morbidity in High Risk Pregnancy: A Case Control Study

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Abstract

Background: Maternal nutrition has been reported to play a critical role in both the development and outcome of pregnancy. But, a causal correlation between obstetric nutrition risk (ONR), pregravid and gravid nutritional status (NS) and pregnancy outcome has not been established. The purpose of this work was to analyze the possible association between ONR, pregravid and gravid NS and maternal morbidity (MM).

Methods: This case control study included 180 pregnant patients admitted for high risk pregnancy (HRP). Patients were allocated in two groups (n = 90 p/group) using the ONR criteria on hospital admission: no nutritional risk group (Group A, ONR score < 3) and nutritional risk group (Group B, ONR score > 3). Study variables included: ONR scores, pregravid and gravid NS and MM.

Results: Average ONR scores were 1.24 ± 0.04 and 3.58 ± 0.07, on admission and 2.63 ± 0.18 and 4.88 ± 0.08 at discharge, on Groups A and B, respectively ($p < 0.001$). Patients were "overweight" and "underweight" in Groups A and B, respectively ($p < 0.05$). Hospital morbidity was identified in 10 (11.11%) and 44 (48.88%) patients in the no nutritional risk and nutritional risk groups, respectively ($p < 0.05$. RR = 2.23; 95% CI 0.36 - 0.81).

Conclusion: There was a positive association between pregravid NS, Obstetric Nutritional Risk and MM in HRP. Nutritionally at-risk patients were underweight, showed a significantly higher morbidity and had longer hospital stays.

Keywords: Malnutrition; Nutritional risk screening; Nutritional status; Undernutrition; High risk pregnancy; Maternal morbidity

Introduction

A high-risk pregnancy (HRP) is one with either an abnormal or pathologic condition, concomitant to gestation or delivery, that threaten the life or health of the mother or fetus [1]. Prevalence of HRP has been reported between 12% and 60%, depending on the country. Some of the risk factors leading to an HRP are woman´s age, nutritional status (diet), diabetes, autoimmune disorders, hypertension, infectious diseases, history of chronic disease and complications in previous pregnancy, multifetal pregnancies and less than 1-year gestational interval [1-3]. A compromised maternal nutrition can result in an adverse outcome of pregnancy and childbirth [4-7]. A clear relationship between maternal malnutrition and adverse pregnancy outcome has been accepted. The consequences are limitless. But, stunting, preeclampsia and increased number of cesarean deliveries are some of them [8-12]. The most important contributing factors to birth weight, in HRP, are stunting and poor weight gain during gestation. Increased nutritional requirements during pregnancy, to maintain fetal growth and maternal metabolism, may further contribute to low weight gain during pregnancy [4,5]. Furthermore, obesity and overweight are additional contributing risk factors to pregnancy outcome. And, prevalence of these two conditions has rocketed in recent years [9,13,14]. The risk of preeclampsia and gestational hypertension increase in the presence of obesity and high body mass index (BMI); because plasma lipids raise significantly during gestation. Women who develop preeclampsia show more considerable lipid changes [13]. It seems likely that women in developing countries are at greater risk of underweight. While, overweight and obesity are more prevalent in women of developed countries and those residing in urban areas with better economic condition [7,15]. Pregnancy complications, cesarean delivery, diabetes, hypertension and prolonged labor have all been associated to overweight and obesity. While stunting and wasting are higher in underweight women [9]. However, there is not a general agreement between Body Mass Index (BMI) measurements and pregnancy outcome. Some reports indicate that a higher BMI is associated to pregnancy complications; while others claim that a lower BMI is closely related to birth outcome. Therefore, maternal underweight, overweight or obesity (malnutrition as a whole) are a threat to maternal and infant health [9,16].

Clinical practice has been affected by the burden of "malnutrition". It has been demonstrated that undernutrition has a direct impact on surgical complications, wound healing and immune function; which lead to prolonged hospital length of stay (LOS) [17-20]. Nutritional condition can further deteriore during hospital stay, worsen the patient´s outcome and increase health care costs [21-24]. Reports indicate that up to 50% of hospitalized patients are malnourished [25-27]. Therefore, the main concern for many years, has been to diagnose malnutrition, on hospital admission [18,22,23]. Accordingly, a nutritional risk screening tool (NRS-2002) was developed by J Kondrup. This methodology is able to identify undernourished patients, the risk of developing undernutrition and whether nutritional support can improve the patient´s outcome in the hospital setting [28,29]. NRS-2002 includes MUST (malnutrition universal screening tool) components and a scoring of severity of disease as an evidence of an increased metabolic rate [7-19,22,28,29] proper nutritional screening has already been documented in patients with different pathologic conditions; such as, cancer, hip fractures, heart and lung diseases [21,22]. Therefore, screening for nutritional risk (NR), at hospital admission, is highly advisable [30-35].

Nutritional status has been associated with the occurrence of numerous diseases [17-20]. Actually, maternal nutrition has a critical role in both the development and outcome of pregnancy [4]. In recent years, the main issue has been to screen for nutritional status (NS) of the hospitalized patient. The idea has been to identify undernourished patients and those at increased risk of malnutrition. But, the lack of evidence about the possible link between obstetric nutritional risk (ONR) and pregravid nutritional status, in the obstetric patient, justified the inclusion of a protocol in patients admitted for HRP. The benefits of NR screening in the obstetric patient with HRP have recently been documented [36]. A higher hospital morbidity was demonstrated in HRP patients who were nutritionally at-risk. Furthermore, their nutritional status worsened during hospital stay. Therefore, individual awareness about the adverse effects of malnutrition might reduce the number of pregnancy complications. Unfortunately, BMI is not stable over time. Yet, current recommendation is to record BMI either before pregnancy or in the first trimester [9]. Still, the main concern is whether preconception nutritional status remains the same throughout pregnancy. Accordingly, a causal correlation between pregravid BMI, obstetric nutritional Risk (ONR) and pregnancy outcome has not been established [37]. The purpose of this study was to analyze the possible association between ONR, pregravid and gravid nutritional status (NS) and maternal morbidity (MM).

Material and Methods

In this case control study, we included 180 pregnant patients admitted for High Risk Pregnancy (HRP) to Hospital of Obstetrics and Gynaecology at Western National Medical Centre, Mexican Institute of Social Security (IMSS). Patients were distributed in two groups (n = 90 p/group) using the Obstetric Nutritional Risk (ONR) Screening criteria reported by Anaya-Prado R et al.: no obstetric nutritional risk group (Group A, ONR score < 3) and obstetric nutritional risk group (Group B, ONR score > 3).(36) Groups were then compared to identify possible association between ONR status (on hospital admission), pregravid and gravid NS and maternal morbidity. Study variables included: ONR screening score, pregravid and on admission BMI (nutritional status) and weight, maternal age, gestation weeks, height, hospital length of stay (LOS) and maternal morbidity. This study included all adult HRP pregnant patients (> 18 y/o) who stayed for a minimum of 3 days in the department of HRP (Figure 1).

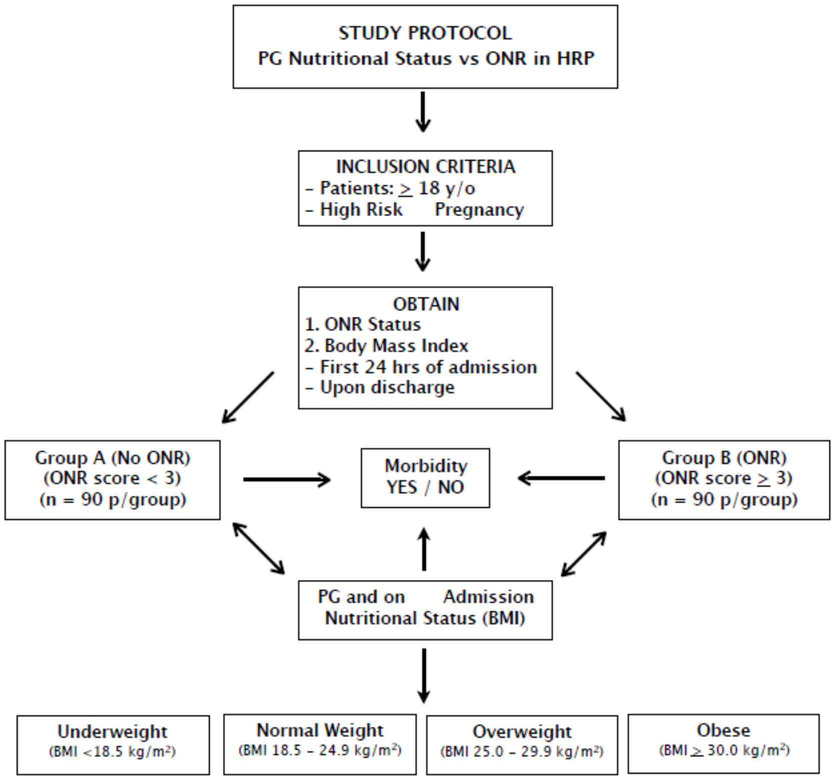

Figure 1: Study protocol that shows inclusion criteria and two groups of patients: no obstetric nutritional risk group (Group A, ONR score < 3) and obstetric nutritional risk group (Group B, NRS score > 3); and possible association with "Pregravid and on admission" nutritional status in accordance with BMI [28,29,36,38,39]. PG, pregravid; HRP, high risk pregnancy; ONR, obstetric nutritional risk; BMI, Body Mass Index; hrs., hours; y/o, years-old; m^2, square meters; kg, kilograms.

Study design

HRP patients were assessed by the group of investigators at the first 24 hours of admission about their Obstetric nutritional risk status in accordance with ONR screening criteria (Table 1). Thereafter, ONR screening was performed upon discharge. Accordingly, every patient received an ONR screening score based on two main categories: nutritional status and disease severity. Nutritional Risk Screening methodology, described by Kondrup et al., and adapted for the obstetric patient with HRP by Anaya-Prado R, et al., has previously been described [28,29,36]. Briefly, the ONR score (0 - 6) was obtained by adding nutritional status score (0 - 3) and disease severity score (0 -3). A total score > 3 was considered nutritionally at-risk. Nutritional status was scored as absent, mild, moderate and severe (0 - 3) based on three different variables: a) changes in estimated food intake, measured in quartiles; b) changes in body weight within the last 1 - 3 months, measured in percentage of body weight loss, and; c) changes in BMI, measured in kg/m^2. Gestational weight gain (GWG) by trimester and pregravid BMI status according to the World Health Organization (WHO) categories: Underweight < 18.5 kg/m^2; Normal weight 18.5 - 24.9 kg/m^2; Overweight 25.0 - 29.9 kg/m^2; Obese > 30 kg/m^2, were considered for BMI range in different scores. Thus, BMI was categorized in accordance with gestational age, GWG by trimester and pregravid BMI (Figure 2) [38,39]. The disease severity score was categorized as absent, mild, moderate and severe (0-3) based on admission diagnosis. Table 1 summarizes how ONR scores were calculated to categorize patients in either group: not at-risk or nutritionally at-risk.

Table 1: Obstetric Nutritional Risk (ONR) Screening Scores in HRP Patients.

Impaired Nutritional Status	Severity of Disease
Absent: Score 0 Normal nutritional status or PG BMI ≥ 20 kg/m², 1st Trim BMI ≥ 20.6 kg/m², 2nd Trim BMI ≥ 23.6 kg/m², 3rd Trim BMI ≥ 25.6 kg/m²	**Absent: Score 0** Normal nutritional requirements during gestation.
Mild: Score 1 Wt. lose > 5% in 3 months or food intake below 50-75% of normal requirements in preceding week or PG BMI 18.6-19.9 kg/m², 1st Trim BMI 19.6-20.5 kg/m², 2nd Trim BMI 21.6-23.5 kg/m², 3rd Trim BMI 23.6-25.5 kg/m²	**Mild: Score 1** Urinary tract infection, respiratory infection, cervicovaginitis, anemia, deep vein thrombosis, antiphospholipid syndrome, thrombocytopenia, systemic lupus erythematosus, epilepsy, gestational hypertension, HIV+, gestational DM, threatened abortion, recurrent abortion, depression, uterine myomatosis, uterine malformations, benign tumor, hypothyroidism, threatened preterm birth
Moderate: Score 2 Wt. lose > 5% in 2 months or food intake 25-50% of normal requirements in preceding week + impaired general condition or PG BMI 17.5-18.5 kg/m², 1st Trim BMI 18.6-19.5 kg/m², 2nd Trim BMI 20.6-21.5 kg/m², 3rd Trim BMI 22.6-23.5 kg/m²	**Moderate: Score 2** Major abdominal surgery, stroke, ROM, preeclampsia, intestinal adhesion syndrome, abruptio placentae, placenta previa, IUGR, oligohydramnios, prematurity, fetal malformations, fetal death, ≥ 3 previous CS, ovarian hyperstimulation, maternal cardiopathy, CRI, posttransplant, AIDS
Severe: Score 3 Wt. lose > 5% in 1 month or > 15% in 3 months or food intake 0-25% of normal requirements in preceding week + impaired general condition or PG BMI ≤ 17.4 kg/m², 1st Trim BMI ≤ 18.5 kg/m², 2nd Trim BMI ≤ 20.5 kg/m², 3rd Trim BMI ≤ 22.5 kg/m²	**Severe: Score 3** SAH, diabetic ketoacidosis, PTE, AKF, placenta accreta, CS with hysterectomy, bowel injury, hemorrhagic shock, trauma in general, TBI, eclampsia, hellp syndrome, chorioamnionitis, sepsis, liver abscess, malignancy, patient in ICU

Obstetric Nutritional Risk (ONR) Screening score can be obtained by adding the scores of impaired nutritional status [1-3] and severity of disease [1-3]. If total score is ≥3, the patient is considered nutritionally at-risk. If total score is <3 the patients is not considered nutritionally at-risk. HRP, High Risk Pregnancy; PG, Pregravid; Trim, Trimester; Wt., weight; HIV, human immunodeficiency virus, DM, diabetes mellitus; ROM, rupture of membranes; IUGR, intrauterine growth restriction; CS, cesarean section; CRI, chronic renal insufficiency; AIDS, acquired immunodeficiency syndrome; SAH, subarachnoid hemorrhage; PTE, pulmonary thromboembolism; AKF, acute kidney failure; TBI, traumatic brain injury; hellp, hemolysis, elevated liver enzymes, low platelets; ICU, intensive care unit. Reproduced with permission from Anaya-Prado et al., Clin Obstet Gynecol Reprod Med 2021; 7(5):1-7 [36].

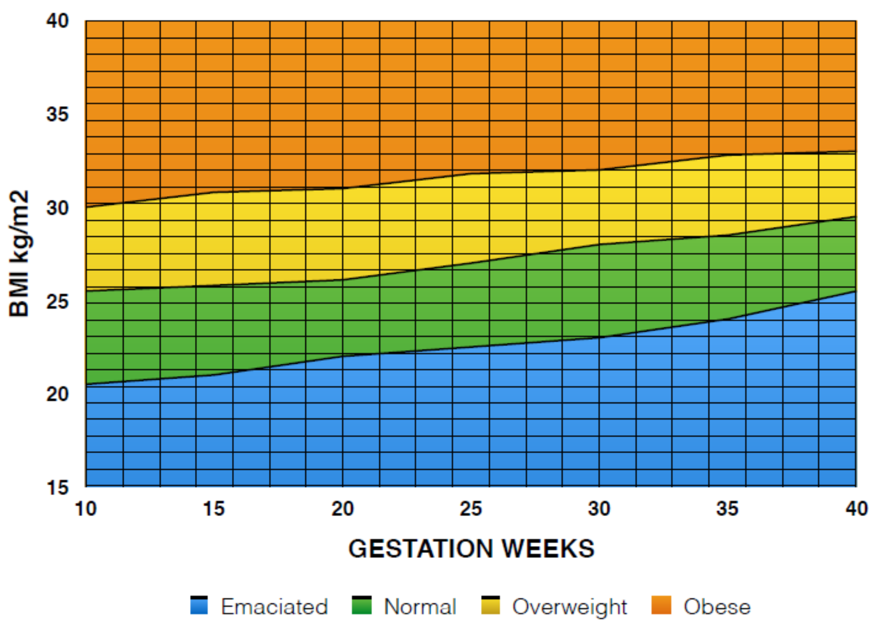

Figure 2: Nutritional assessment during pregnancy in accordance with BMI and gestation weeks. This nomogram considers rate of weight gain during pregnancy. Nutritional status was defined by observing the point right where "Y" (BMI) and "X" (Gestation weeks) lines converge. BMI, body mass index; kg, kilograms; m², square meters. Adapted from Atalah E, et al. [39].

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Ethics

The protocol was submitted and approved by the Local Hospital Ethics and Research Committee and all information and patient data were handled and processed by the investigators, ensuring confidentiality at all times. Even though this investigation adhered to principles of good clinical practice and that the risk was less than the minimum, informed consent was obtained, and all patients agreed to participate in this study.

Statistical analysis

Outcome variables are presented in raw numbers or percentages. For qualitative variables, the Pearson´s correlation and Chi^2 test, with Yates correction, or Fisher exact test were utilized; and results are presented in percentages and proportions. Quantitative variables are expressed as mean ± standard deviation of the mean (SDM), compared by Student's t test for independent samples and results are reported on averages. The Mann-Whitney rank sum test was applied when normality test failed. Data were analyzed by one-way analysis of variance (ANOVA) procedure, followed by the Student-Newman-Keuls' test to determine differences between individual means. Turkey test and Dunn method were also utilized for paired multiple comparisons. The analysis was performed using SigmaStat® (release 4.0), SPSS (release 8.0) and SAS (release 6.12). A P value equal to or less than 0.05 was considered statistically significant.

Results

Average gestation age, maternal age, height and length of stay was 31.8 ± 7.5 and 31.3 ± 8.3 weeks ($p = 0.181$); 29.6 ± 0.6 and 27.7 ± 0.6 years ($p = 0.036$); 1.58 ± 0.06 and 1.64 ± 0.03 meters ($p < 0.001$); and 4.78 ± 0.30 and 7.44 ± 0.46 days ($p < 0.001$) for the not at-risk and nutritionally at-risk groups, respectively (Groups A and B). Difference between the two groups was statistically significant, except for gestation age (Table 2).

Anthropometric measurements

Average prepregnancy, on admission and at discharge body weight was 66.8 ± 13.05, 76.6 ± 12.32, and 73.6 ± 12.39 kg ($p < 0.001$); and 49.5 ± 4.13, 58.7 ± 5.0 and 54.1 ± 4.4 kg ($p < 0.001$) for the not at-risk and nutritionally at-risk groups, respectively (Groups A and B). Average prepregnancy, on admission and at discharge BMI was 26.5 ± 4.64, 30.3 ± 4.21 and 29.2 ± 4.34 kg/m^2 ($p < 0.001$); and 18.0 ± 1.07, 21.4 ± 1.43 and 19.8 ± 1.35 kg/m^2 ($p < 0.001$) for Groups A and B, respectively. All pair-wise multiple comparisons (Dunn Method) demonstrated a statistical significant difference ($p < 0.05$), except when comparing weight and BMI on admission vs discharge in the no nutritional risk group; and when comparing BMI on pregestation vs discharge in the not at-risk and nutritionally at-risk groups, respectively (Table 2, Figures 3A,3B).

Table 2: ONR Screening in HRP and Interval Anthropometric Measurements.

			Pregravid	On Admission	At Discharge	P value
No Nutritional Risk (ONR score < 3) (n = 90)						
Age	(Years ± SD)		29.6 ± 5.7			=0.036
Weight	(Kg)	(M ± SD)	66.8 ± 13.05	76.6 ± 12.32	73.6 ± 12.39	< 0.001†
BMI	(kg/m^2)	(M ± SD)	26.5 ± 4.64	30.3 ± 4.21	29.2 ± 4.34	< 0.001†
Height	(M)	(M ± SD)	1.58 ± 0.006			< 0.05†
Gestation Weeks	(Weeks ± SD)			31.8 ±7.5		> 0.05*
Length of stay	(Days ± SD)				4.78 ± 0.30	< 0.001
Nutritionally at-Risk (ONR score > 3) (n = 90)						
Age	(Years ± SD)		27.7 ± 5.7			=0.036
Weight	(Kg)	(M ± SD)	49.5 ± 4.13	58.7 ± 5.0	54.1 ± 4.4	< 0.001†
BMI	(kg/m^2)	(M ± SD)	18.0 ± 1.07	21.4 ± 1.43	19.8 ± 1.35	< 0.001†
Height	(M)	(M ± SD)	1.68 ± 0.003			< 0.05†
Gestation Weeks	(Weeks ± SD)			31.3 ± 8.3		> 0.05*
Length of stay	(Days ± SD)				4.78 ± 0.30	< 0.001

†P < 0.05, all pair-wise multiple comparisons (Dunn method), except when comparing weight and BMI on admission vs discharge in the no nutritional risk group; and when comparing BMI on pregestation vs at discharge in the no nutritional risk and nutritional risk groups, respectively. *P > 0.05, when comparing gestation weeks in the no nutritional risk vs nutritionally at-risk groups. ONR, obstetric nutritional risk; HRP, high risk pregnancy; BMI, body mass index; M, meters; Kg, kilograms; M ± SD, Mean ± Standard Deviation

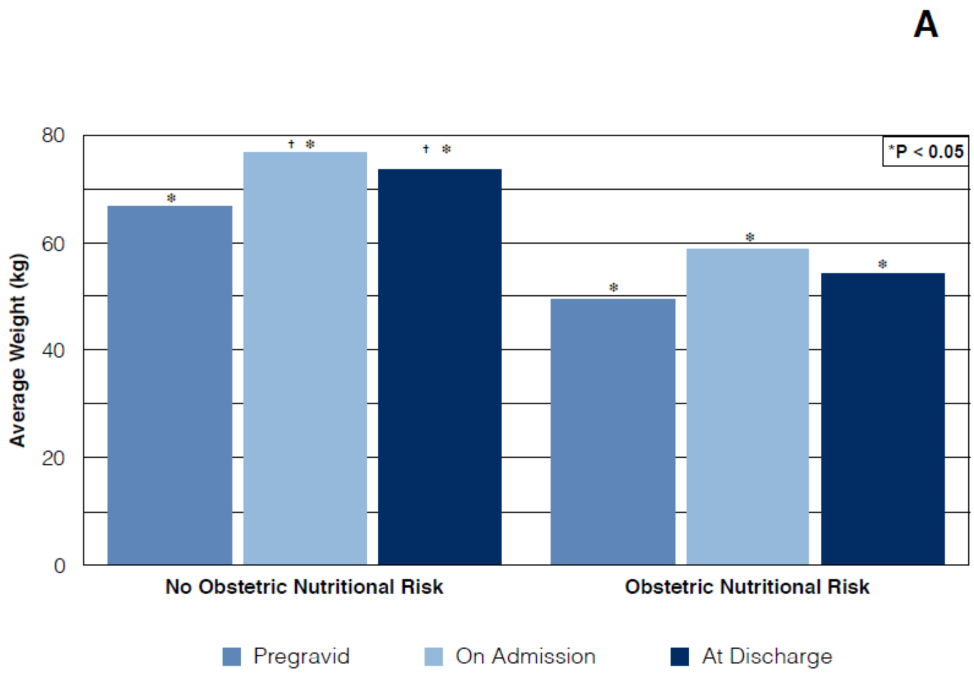

Figure 3A

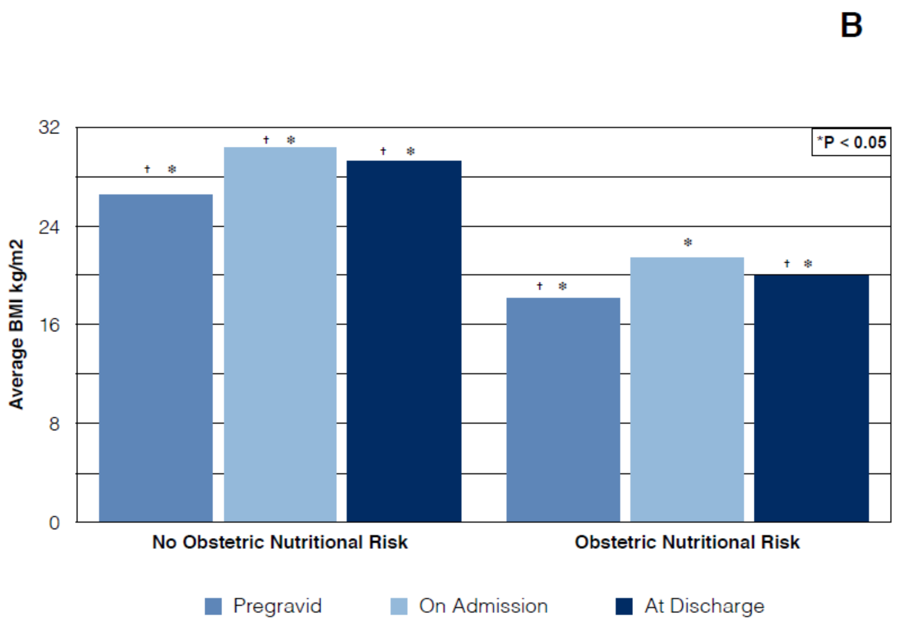

Figure 3B

Figure 3A & B: Average pre-pregnancy, on admission and at discharge body weight (A) and BMI (B). *P <0.001, all pair-wise multiple comparisons (Dunn Method). + P>0.05 on admission vs discharge in the no nutritional risk group (A & B); and pregestation vs discharge in the no nutritional risk and nutritionally at-risk groups, respectively (B). BMI, body mass index; kg, kilograms; m2, square meters.

In accordance with "Pregravid" and "Gravid (on admission)" BMI measurements, patients were "overweight" and "underweight" in the no ONR and the ONR groups, respectively (Groups A and B). Difference between both groups was statistically significant (p <0.05). That is, Pregravid nutritional status remained the same throughout pregnancy, up to hospital admission (Table 2). Average ONR screening scores were 1.24 ± 0.04 and 3.58 ± 0.07, on admission and 2.63 ± 0.18 and 4.88 ± 0.08 at discharge, for the "not at-risk and nutritionally at-risk" groups, respectively (Figure 4). Comparison of on admission and at discharge median scores were significantly different (p <0.001) in both groups (Kruskal-Wallis ANOVA on ranks). All pair-wise multiple comparisons: on admission vs discharge and no nutritional risk vs nutritionally at-risk demonstrated a statistically significant difference (Turkey test and Dunn method). Additionally, thirty-three percent (n =30) of the patients in the "no nutritional risk" group became "nutritionally at-risk when screened at discharge (p <0.03). Similarly, 73.33% (n = 66) of the patients identified as "nutritionally at-risk" on admission, developed higher scores when screened at discharge (p <0.05). Hospital morbidity was observed in 10 (11.11%) and 44 (48.88%) patients in the no nutritional risk and nutritional risk groups, respectively (Figure 5). The difference between the two groups was statistically significant (p <0.05. RR = 2.23; 95% CI 0.36 - 0.81). There was a positive association between pregravid and on admission nutritional status (underweight), obstetric nutritional risk and hospital morbidity (p <0.05, X^2 = 30.58).

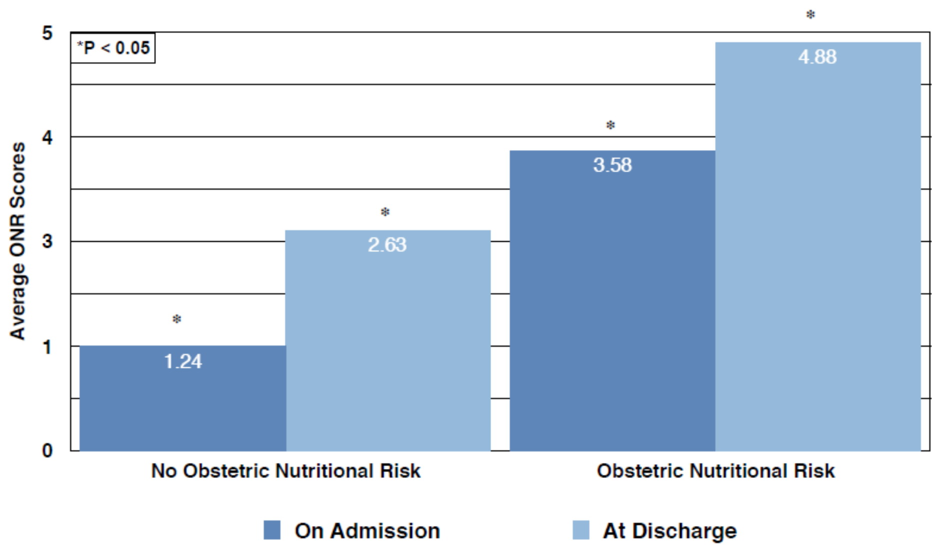

Figure 4: Average ONR screening scores, on the first 24 hours of admission. *P < 0.05, paired multiple comparisons (Turkey test and Dunn method) on all possible combinations. ONR, obstetric nutritional risk; HRP, high risk pregnancy.

Discussion

In this study, we were able to demonstrate a positive association between pregravid nutritional status, obstetric nutritional risk (on hospital admission) and maternal morbidity in HRP patients. In accordance with pregravid and gravid BMI, nutritionally at-risk patients were underweighted and showed a significantly higher morbidity. While, not at-risk patients were, on average, obese. This shows that maternal nutritional status remained the same from preconception up to delivery, in both groups. Our main concern was to identify whether obstetric nutritional risk (ONR) was linked to either pregravid or gravid nutritional condition (BMI). The importance of screening NR on hospital admission has been shown in different specialties, such as cancer patients and those being treated for heart and lung disease [28-30,34,35,40,41-45]. And, recent evidence demonstrates that ONR has a negative effect in morbidity on HRP patients [36]. The development and outcome of pregnancy can be affected by maternal nutrition [4]. Actually, NS has been associated to the occurrence of numerous diseases [17-20]. The global prevalence of maternal undernutrition and its short and long-term consequences, in low and middle-income countries, has already been documented [8,11,12]. For some years now, the issue has been to screen for malnutrition of the hospitalized patient. Identifying malnourished patients, on hospital admission, may help structure adequate nutritional plans; so, in-hospital morbidity and mortality can be lowered.

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Although it is believed that there is a physiologic adaptation (hypothesis of nutritional fetal origins) to nutritional status during pregnancy; nutritional requirements increase in order to cope with the needs of fetal growth [4-7,46,47]. Some studies suggest that giving nutritional supplements to pregnant women might have a positive impact on adult life of their offspring's. However, improving nutritional status during pregnancy has not demonstrated a direct impact on offspring outcome [46]. Furthermore, a link between reduced birthweight and poor fetal growth or stunting has been accepted [8,11,12]. It has been argued that a baby of low birthweight (which may be the consequence of poorer nutrition in utero), who is stunted and underweight in early childhood and gains weight rapidly, can suffer from cardiovascular and metabolic diseases in adult life [46]. Actual consequences of poor nutritional status during pregnancy reported by these observational studies. So, maternal undernutrition has a real impact on outcome for both the mother herself and her offspring [4,8,11,12]. Thus, the risk of malnutrition with its consequences, in the hospital setting, is latent and pregnant women are not the exception [27].

Following BMI measurements, we observed that nutritionally at-risk patients were underweight; while not at-risk patients were obese. We also noticed that HRP patients, who were nutritionally at-risk, had significantly longer hospital stays, as compared to patients who were in the no nutritional risk group. Thus, screening for ONR at hospital admission should be performed on HRP patients, as suggested for other conditions. Some studies have reported Mini Nutritional Assessment (MNA) questionnaire to be superior to NRS-2002 in predicting hospital length of stay (LOS). Nonetheless, other reports indicate that NRS-2002 is a better predictor of hospital full length than MNA, Subjective Global Assessment (SGA) and Malnutrition Universal Screening Tool (MUST) [17,47,49]. Irregardless of the screening tool, a significant association between nutritionally at-risk and increased LOS has been accepted by different studies [21,44]. Actually, previous investigations have demonstrated that protein-energy malnutrition is a strong and independent risk factor associated with morbidity, mortality, prolonged LOS and higher complication rates, including infections [50-52]. Fasting, loss of appetite, depression, along with a poor hospital diet may further compromised NS. This might as well explain why, in our study, ONR screening scores worsened during hospital stay, in both groups, when screened at discharge. Most patients are fasted on hospital admission; which is a common practice in many hospitals. These results demonstrate that ONR is a useful tool to identify HRP patients with either poor or good nutritional condition. Whether nutritionally at-risk HRP patients might benefit from some type of nutritional support, remains to be investigated. Thus, our results are consistent with those previously reported by others; but, in conditions different than pregnancy [17,21,53].

As stated by Kondrup, the goal of assessing NR, at hospital admission, has been to anticipate the possibility of a worse or better outcome due to nutritional conditions and whether nutritional support can benefit patients´ outcome [28,29]. Therefore, in an effort to demonstrate that nutritional support lowers morbidity and mortality in nutritionally at-risk patients, a great deal of research has been done in different scenarios (pathologies). In a large cross-sectional study performed by Skeie, et al., in mixed surgical patients, a positive association between nutritional risk and incidence of surgical site infection (SSI) was demonstrated [54]. Among the questions utilized to define NR, both reduced dietary intake and weight loss were the strongest associated with infection in this study. Furthermore, nutritionally at-risk patients were older, had urgent surgeries, had lower BMI and tended to have higher ASA scores [54]. In our study, lower BMI (underweight) was associated with ONR and higher morbidity. Our results are consistent with other reports that indicate higher odds of stunting and wasting among underweight women [9]. In our study, only one patient in the nutritionally at-risk group developed sepsis. However, chorioamnionitis, preeclampsia, and Hellp syndrome were the most frequent complications reported in the nutritionally at-risk cohort. The role of maternal diet in the aetiology of preeclampsia has recently received significant attention. Current knowledge, in non-pregnant patients, indicates that specific nutrients may be involved in some steps in the pathogenesis of preeclampsia. It has also been suggested that nutrients such as trace elements, fatty acids and folic acid can contribute to insulin resistance which is a key risk factor for preeclampsia [10]. Authors argue that maternal nutritional imbalance can lead to altered gene expression and methylation and homocysteine metabolism and to an increased inflammatory response with oxidative stress.

In order to lower morbidity and mortality, as well as the consequences of a prolonged hospital stay, proper nutritional interventions should be instituted on nutritionally at-risk patient [21,22]. Since food is commonly utilized to treat nutritional deficiencies within the hospital setting, Munk et al. compared an energy-enriched food menu versus a standard hospital food menu [55]. These authors found a significant positive impact on overall protein intake and on weight-adjusted energy intake in nutritionally at-risk patients. Thus, increasing protein and energy intake in hospitalized patients is feasible through hospital food menus. As suggested, NR screening can help tailor some type of nutritional support which will certainly improve the outcome of the hospitalized patient. In our hospital, ONR is not performed nor does nutritional support is indicated on a regular basis. That is, nutritional support is indicated only whenever there is a complication. Possible explanations, as recognized by others, are lack of nutritional education, undefined responsibilities and time of the healthcare personnel [21,44,56]. Nevertheless, we acknowledge the need for an adequate nutritional screening and therapy in order to lower maternal morbidity and mortality as well as to improve pregnancy outcome.

Since we found a direct association between pregravid, gravid and "obstetric nutritional risk status"; maternal weight management is highly advisable to prevent adverse mother and birth outcomes. The importance of this association relies on how well we provide appropriate prenatal care. It has been demonstrated that good prenatal care is associated with decreased maternal mortality, preterm birth, neonatal death and stillbirth [57]. Nonetheless, clinicians should be aware that even with the best care approach, HRP patients will still be at risk of poor neonatal outcome. So, the goal should be aimed at reaching a term pregnancy with a not at-risk nutritional status, on hospital admission; thereby, an improved maternal and childbirth outcome. Our results indicate that prenatal care is somehow missing maternal weight control; since nutritionally at-risk patients were underweight all along pregnancy. Controlling weight may significantly reduce the number of pregnancy complications. An acceptable maternal nutritional status might as well improve pregnancy outcome; thereby reducing the incidence of HRP. Identifying patients who are nutritionally at-risk, on hospital admission, will surely help us tailor some type of nutritional plan. However, every effort should be aimed at counselling women prior to or early in pregnancy, in order to avoid underweight, overweight or obesity. Informed women may as well try to optimize their BMI before conception. Whether HRP patients, who are nutritionally at-risk, will benefit from some type of nutritional support remains to be elucidated. Though, it has been demonstrated that outcome improves when nutritionally at-risk non-obstetric patients are properly treated [58]. Therefore, ONR screening should be implemented on HRP patients, not only to lower morbidity and mortality; but to identify whether perinatal outcome can also be improved. It can be presumed that, there would be a positive effect on hospital LOS and costs, should proper nutritional therapy be instituted. Further investigation will be necessary to demonstrate this hypothesis. Finally, HRP has been associated to perinatal morbidity and mortality; however, the impact of ONR on neonatal outcome remains to be investigated [59].

In conclusion, we found a positive association between pregravid and gravid (on hospital admission) nutritional status, obstetric nutritional risk and maternal morbidity in HRP. Nutritionally at-risk patients were underweighted and showed a significantly higher morbidity. That is, obstetric nutritional risk, on hospital admission, is linked to preconception nutritional status in accordance with BMI. Whether ONR status can be modified with a good prenatal weight control remains to be demonstrated.

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Conflict of Interest

Authors declare no conflict of interest.

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