

The Valsalva maneuver duration during labor expulsive stage: repercussions on the maternal and neonatal birth condition

Duração da Manobra de Valsalva durante o período expulsivo do parto: repercussões maternas e nas condições neonatais de nascimento

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Abstract

Objectives: This cross-sectional study was designed to examine the effects of the Valsalva Maneuver (VM) and its duration on the acid-base equilibrium of the neonate and its maternal repercussions during the expulsive stage of labor, after standard breathing and pushing instructions were given. **Methods:** A convenience sample of women with low risk pregnancy ($n=33$; mean age 22.5 ± 3.7 y and gestational age 38.1 ± 1.12 wks) and their newborns were studied during the expulsive stage of vaginal labor. Coaching consisted of standard recommendations for breathing including prolonged VMs coordinated with pushing. Maternal outcomes included the need for uterus fundal pressure maneuver and episiotomy, perineal trauma and posture. Neonatal outcomes included blood gases sampled from the umbilical cord, and Apgar scores. Data were analyzed with the Fisher's exact test, chi-square test, and Pearson correlation coefficient. **Results:** None of the maternal outcomes were associated with VM duration. With respect to neonatal outcomes, increased VM duration was associated with reduced venous umbilical pH ($r=-0.40$; $p=0.020$), venous base excess ($r=-0.42$; $p=0.014$) and with arterial base excess ($r=-0.36$; $p=0.043$). Expulsive stage time was negatively associated with umbilical venous and arterial pH. **Conclusions:** VM duration during fetal expulsion in labor negatively affects fetal acid-base equilibrium and potentially the wellbeing of the neonate. Our results support the need to consider respiratory strategies during labor, to minimize potential risk to the mother and neonate.

Key words: Valsalva maneuver; pushing; "labour, obstetric"; umbilical cord.

Resumo

Objetivos: O presente estudo de corte transversal teve como objetivo avaliar os efeitos da Manobra de Valsalva (MV) e sua duração no equilíbrio ácido-básico fetal e nas repercussões maternas durante o período expulsivo do parto, após instrução respiratória padronizada. **Métodos:** Uma amostra de conveniência em gestantes de baixo risco ($n=33$, média de idade $22,5\pm 3,7$ anos e idade gestacional $38,1\pm 1,12$ semanas) e seus neonatos foi avaliada durante o período expulsivo do parto vaginal. O treinamento consistiu em recomendações padronizadas para respiração, incluindo MV prolongadas associadas ao puxo. Os desfechos maternos incluíram o uso da manobra de pressão para o fundo do útero, episiotomia, trauma perineal e postura. Os desfechos neonatais incluíram análise dos gases sanguíneos do cordão umbilical e valores de Apgar. Os dados foram analisados por meio do teste exato de Fisher, teste qui-quadrado e Coeficiente de Correlação de Pearson. **Resultados:** Nenhum dos desfechos maternos foi associado com a duração da MV. No entanto, em relação aos desfechos neonatais, o aumento da duração da MV foi associado com redução do pH venoso umbilical ($r=-0,40$; $p=0,020$) e excesso de base ($r=-0,42$; $p=0,014$) e com o excesso de base arterial ($r=-0,36$; $p=0,043$). O tempo do período expulsivo do parto foi negativamente associado com o pH venoso e arterial. **Conclusões:** A duração da MV durante esse período do parto interfere negativamente no equilíbrio ácido-básico fetal e potencialmente no bem-estar do neonato. Esses resultados fornecem suporte para a necessidade de os fisioterapeutas considerarem estratégias de orientações respiratórias para o puxo durante o trabalho de parto para minimizar potenciais riscos para a mãe e o neonato.

Palavras-chave: Manobra de Valsalva; puxo; parto; cordão umbilical.

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Introduction

Childbirth is characterized by spontaneous alterations in the mother's breathing coordinated with the generation of marked thoracic and abdominal pressures to assist with expulsion of the fetus. Although normally spontaneous and unconscious, breathing becomes a voluntary and controlled activity during labor, induced by the physiologic mechanisms to facilitate this process¹. Breathing patterns are characterized by periods of normal breathing interspersed with Valsalva maneuvers (VMs). VM strengths, frequencies, and durations are dependent on the stage of labor².

During the expulsive stage of labor, the fetus is propelled caudally as a result of the high thoracic and abdominal pressures generated by the mother coordinated with breathing and muscle contraction. Such efforts increase the pressure on the levator ani muscles of the pelvis which generates a reflex, involuntary urge to bear down strongly, referred to as the push stage. Associated with involuntary intra uterine contractions, a voluntary expulsive effort is manifested, through the abdominal and respiratory muscles, to facilitate the delivery of the neonate³. The woman may also voluntarily bear down. While involuntary bearing down efforts are typically short (<6 seconds), voluntary bearing down efforts directed by the care giver are often longer, and up to 10 seconds⁴.

Standard childbirth practices tend to promote prolonged duration of the VM (i.e., 10 s or more) which has been the focus of some studies^{5,6}. Some investigators; however, have argued that breathing control interventions should not be imposed. Rather, the mother should adopt a breathing pattern including the VM in accordance with what she instinctively requires⁷⁻⁹. When a woman who is delivering breathes in accordance with her needs rather than having a pattern imposed, her respiratory efforts typically involve breathing with an open glottis, rather than a closed glottis, such as the case during a VM, and when she uses the closed glottis is only for a maximum of 4 to 6 seconds⁹.

Irrespective of the debate, evidence to support either point of view is scarce. Some physiologic evidence supports the avoidance of VMs of 10 seconds or more during labor and delivery⁶. Despite several papers^{4,5,7-9} supporting its adverse maternal and fetal effects, prolonged VMs continue to be promoted in the literature. Furthermore, no study to date has specifically examined the relationship between the VM and its duration, on maternal and neonatal outcomes, and the implications for recommendations regarding preparation for childbirth.

This study was designed to further explore the role of controlled VM reported in the literature by examining the relationship of VM duration on maternal and neonatal outcomes. Maternal outcomes included the need for uterus fundal pressure maneuver, episiotomy, perineal trauma and labor posture.

Neonatal outcomes included umbilical cord blood pH, base excess, PCO₂ and Apgar scores.

Methods

Participants

A cross-sectional study was conducted using a sample of convenience. This was a pilot study as there were no references in the literature of research studies using similar methodology that could be used for sample size calculation. Inclusion criteria were pregnant women (both primipara and multipara), between 18 and 35 years of age, with fetus gestational age between 37 and 41 weeks based on the last menstruation date, and that were admitted to the hospital at the first stage of labor, and were classified as low-risk. Additional criteria were cephalic presentation of the fetus, the mother's membranes had been intact during early labor, and the presence of one live fetus. The attending obstetrician who was blind to the specific intent of the study, established whether the inclusion criteria were met. Mothers for whom umbilical cord compression, forceps and analgesia were indicated, were excluded, because their fetus could experience acute distress (signs of hypoxia). This determination was also based on the independent assessment of the obstetrician. Based on normal procedures, women for whom 2% lidocaine was indicated during an episiotomy, were retained. This research was approved by the Research Ethics Committee of the Universidade Federal de Pernambuco (UFPE), Recife, PE, Brazil under protocol number: 005/2002. Subjects were included in the study after having the study described, and providing informed signed consent.

Data collection during the expulsive stage of labor

Participating mothers were assessed by members of the obstetrical team during the expulsive stage of labor, with the initial and final stages defined by 10 cm cervical dilatation and fetal body expulsion, respectively. The duration of this interval was recorded. Traditional instructions were given to the mothers by the attending nursing staff who were also blind to the specific intent of the study. Mothers were instructed to push hard during each contraction, and at the same time take a deep breath, and hold it for as long as they could, using VM to facilitate this strong effort¹¹. During this stage, the duration of each VM was recorded with a calibrated chronometer (Cronobio, SW-2018, São Paulo, SP), along with the number of VMs. The average VM duration was considered as the expulsive stage VM value. A pulse oximeter (J.G. Moriya-1001, São Paulo, SP) positioned on the left index finger was used to assess oxygen saturation (SpO₂) and maternal heart rate during each maneuver. The body position

of the mother was recorded. The position was described as supine when the angle between the mother's trunk and legs was less than 30°, and as vertical, when this angle was 30° or greater based on the elevation of the trunk. The need for oxytocin was assessed by the attending medical and nursing staff according to commonly-used delivery procedures, i.e., 1 oxytocin ampoule.

Umbilical cord blood gas analysis

Immediately after birth, the umbilical cord segment was doubly clamped and isolated for blood collection. With two 10 ml syringes flushed with .06 ml heparin 5000 UI/ml, 0.2 to 0.3 ml of blood were taken, first from the umbilical artery and then from the umbilical vein, thereby eliminating any residual air trace. The cord blood gas analysis was conducted immediately using a gasometer (GEM-Premier 3.000-Instrumentation Laboratory Company, MA-USA). The analysis of blood pH, PCO₂ and base excess were performed for each of the two samples (arterial and venous).

Maternal outcomes

Post delivery, the following maternal outcomes were recorded: whether the uterus fundal pressure maneuver was needed (i.e., an externally-applied mechanical force to the abdomen at the level of the uterus fundus), the need for an episiotomy, and the degree of perineal trauma. Perineal trauma were classified

as first degree when there was an injury to the skin and mucosa, second degree when there was muscle injury, third degree when there was injury involving the anal sphincter and fourth degree and there was injury to the rectum mucosa³.

Neonatal outcomes

The neonatal outcomes were extracted from the medical record: Apgar scores¹⁰ for the 1st and 5th minutes after birth (normal value being greater than a score of 7), and the body weight. Normal neonatal body weight was based upon the Brazilian population average of 3390 g¹¹.

Statistical analysis

The following maternal variables were analyzed as categorical data: parity, body position, need for the uterus fundal pressure maneuver, use of oxytocin, episiotomy, and the neonatal's variables of weight and Apgar scores. Continuous data were analyzed descriptively by means and standard deviations. To examine the association between categorical variables and VM duration, the latter was classified into two categories based on the mothers' spontaneous pushing efforts commonly reported in the literature⁴: ≤6 s and >6 s. Chi-square tests were used to analyze these data. When the assumptions of the chi-square test were not satisfied, the Fisher's exact test was used. To rule out a potential cumulative physiologic and psychological stress effects on the variables of interest, the duration of the overall labor was correlated with the acid base variables of the neonate. Associations among the continuous variables were analyzed using Pearson's correlation coefficient. An α level of ≤.05 was set for all tests.

Table 1. Categorical variable data for the mother and neonate separated by the duration of the Valsalva maneuver.

Variable	Valsalva Maneuver Duration (s)				p value
	≤6		>6		
	n	%	n	%	
Parity of the mother					0.65 ^{ns}
Primipara	11	57.9	7	50	
Multipara	8	42.1	7	50	
Mother's body position					1.00 ^{ns}
≤30°	12	63.2	11	78.6	
>30°	7	36.8	3	21.4	
Uterus fundal pressure maneuver					0.50 ^{ns}
Performed	6	31.6	6	42.9	
Not performed	13	68.4	8	57.1	
Ocitocin					0.16 ^{ns}
Administered	9	47.4	10	71.4	
Not administered	10	52.6	4	28.6	
Episiotomy					0.67 ^{ns}
Performed	14	73.7	12	85.7	
Non performed	5	26.3	2	14.3	
Fetal weight (g)					1.00 ^{ns}
≤3390	13	68.4	10	71.4	
>3390	6	31.6	4	28.6	
Fetal Apgar score					0.62 ^{ns}
≤7	3	15.8	1	7.1	
>7	16	84.2	13	92.9	

ns=non significant at p≤.05.

Results

Thirty three mothers were included in this study. Mother's mean age (±SD) was 22.5±3.7 years, and the mean gestational age was 38.1±1.12 weeks. There was no evidence of arterial desaturation, defined as less than 96% oxygenation, in any mother throughout the study period. In addition, no association was observed between VM duration and maternal heart rate that was continuously monitored and recorded during each push (r=0.26; p=0.142). Only 7 women who were multipara required no episiotomy, and among them, 6 exhibited a first degree, and one, a third degree perineal injury. No associations were observed between maternal and infant's weight, Apgar scores and VM duration (Table 1). Nine neonates exhibited an umbilical artery pH <7.2; of which 6 (66.7%) were neonates of the subgroup of women with a VM duration >6 s. Only 3 neonates had an 1st minute Apgar score of <7. All neonates had normal Apgar scores when assessed at the 5th min.

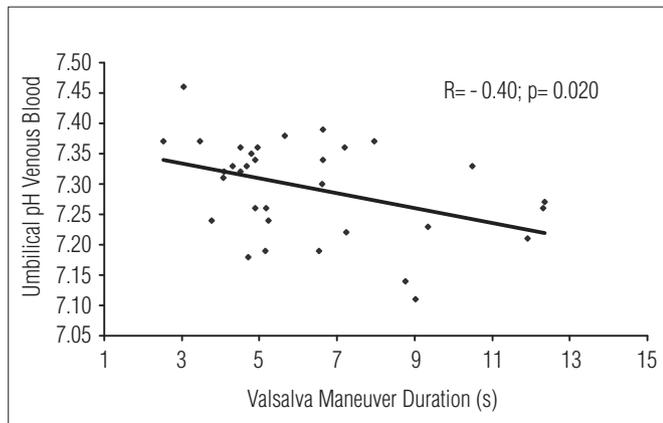


Figure 1. Relationship between the duration of the Valsalva maneuver during the expulsive stage of labor and umbilical venous pH ($r=-0.40$; $p=0.020$).

A reduction was noted in venous umbilical pH ($r=-0.40$; $p=0.020$; Figure 1) and venous base excess ($r=-0.42$; $p=0.014$; Figure 2) in relation to VM duration, but this was not observed in the venous PCO_2 ($r=0.25$; $p=0.167$). There was no association between VM duration and arterial umbilical PCO_2 ($r=-0.22$; $p=0.219$), and arterial pH (Figure 3), but an association with the arterial base excess was observed ($r=-0.36$; $p=0.043$). There was no relationship between VM duration and the expulsive stage time ($r=0.10$; $p=0.595$). However, when the expulsive stage time was compared to the umbilical venous and arterial pH ($r=-0.30$; $p=0.092$), there was a negative association with the umbilical venous pH ($r=-0.41$; $p=0.017$; Figure 4). Finally, no associations were observed between the duration of labor (1st and 2nd stages) and the umbilical arterial pH or venous pH ($r=0.31$ and $p=0.19$; $r=0.27$ and $p=0.176$, respectively).

Discussion

This study was designed to further evaluate the evidence for breathing control recommendations that are taught by health care team to expectant women, and coached during the pre-natal period and labor. The uniqueness and importance of this study, is that manipulation of the VM duration is common in perinatal instruction, yet its potential impact has not been well studied. This is the only study to our knowledge that has considered the relationship between duration of the VM and various maternal and newborn outcomes; and that considered that prolonged bearing down efforts using VM may be associated with risks to the newborn.

In this study, a prolonged VM period was associated with reduced umbilical venous pH and venous base excess of the neonate. These findings are consistent with the potential for acidosis, given there was no relationship between umbilical

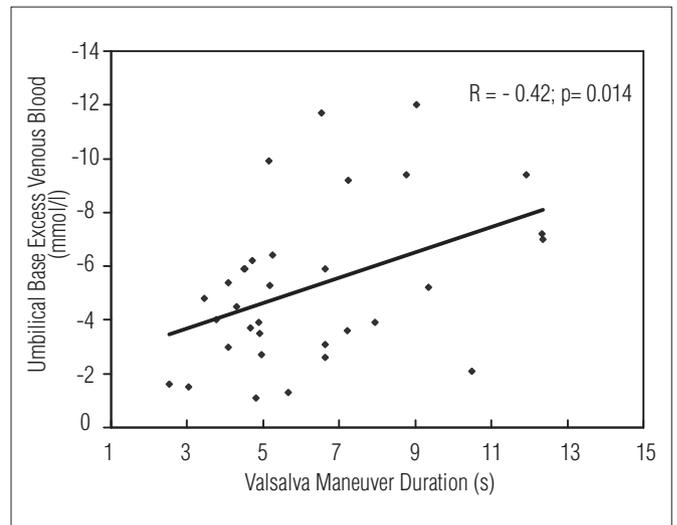


Figure 2. Relationship between the duration of the Valsalva maneuver during the expulsive stage of labor and umbilical venous base excess.

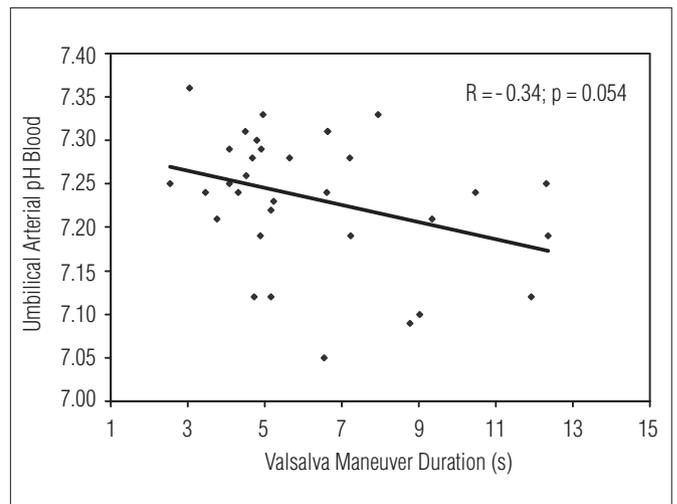


Figure 3. Relationship between the duration of the Valsalva maneuver during the expulsive stage of labor and umbilical arterial pH.

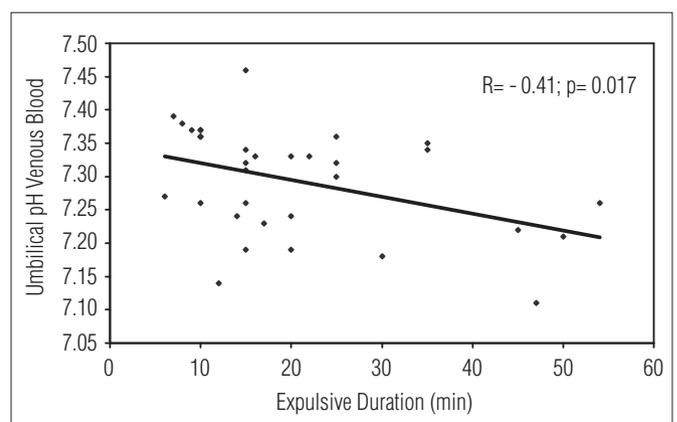


Figure 4. Relationship between the duration of the expulsive stage of labor and umbilical venous pH.

venous PCO_2 and VM duration. Venous blood flowing from the placenta directly to the fetus reflects the maternal acid-basic status¹². The gas values of this blood are similar to the acid-base status and the oxygen content of the maternal intervillous space, because oxygen and carbon dioxide are balanced between these compartments¹³.

The findings support that an extended period of apnea associated with the mother's muscle effort to maintain bearing down during the expulsive stage of labor, can negatively affect fetal acid-base balance, demonstrated by a reduction in base excess in the umbilical vein. Abnormal umbilical acid base balance has been associated with increased fetal stress and birth-related injuries¹⁴.

With progressive pushing by the mother with increasing intensity, duration, and frequency, the lactate concentration increases in the mother's blood causing metabolic acidemia, and the blood reaches the umbilical vein with a low pH¹⁵. Thompson¹⁶ reported that a prolonged expulsive stage is risky for the fetus, when the mother experiences prolonged apneic episodes, and observed a reduction in the time-related venous pH, particularly in the group characterized by prolonged VMs. Barnett and Humenick¹⁷, comparing women who used open glottis during VM for pushing with women who used a closed glottis, reported that the umbilical venous pH remained higher in women who performed VMs with an open glottis. This is an interesting observation given that some women are spontaneously vocal during end-stage labor. Vocalization requires that the glottis is open. Childbirth practices in some cultures that encourage women to be stoic and non vocal may not be advantageous to the neonate.

The maternal cardiorespiratory load imposed by prolonging the VM may interfere with the wellbeing of the fetus. When pushing in conjunction with a strong VM, the mother increases abdominal pressure, which can result in pressures higher than the uterus blood perfusion, reducing uterus-placental blood flow¹⁸. This effect could alter the oxygen content available to the fetus due to the development of acidemia secondary to anaerobic metabolism¹⁹.

The umbilical cord arterial blood reflects the fetal acid-base status, and a pH of less than 7.2 is an indicator of fetal acidemia²⁰. In our study, 27.2% of the neonates had an arterial $\text{pH} < 7.2$. Although arterial pH tended to decrease with VM duration, this finding was not statistically significant. When the VM duration increased, the arterial base excess decreased; however, no relationship was observed with arterial PCO_2 . Caldeyro-Barcia et al.⁸ reported higher levels of venous and arterial pH in a sample of women in labor who used the VM with an average duration of 5 s. This finding supports that VM duration is an important variable with respect to maintaining optimal acid base balance.

When the placenta function is abnormal or a maternal acid-base disturbance is present, both the arterial blood and venous blood are abnormal. Women in labor showing changes in venous pH and venous base excess also show changes in the arterial values. Thus, maternal respiratory patterns may interfere with the fetal acid-base equilibrium¹².

The primary purpose of prolonging the VM in women in end stage labor is to facilitate the expulsion of the neonate and potentially shorten labor⁶. In the present study, there was a relationship between the expulsive stage duration and low venous pH. However, there was no relationship between the duration of this stage with that of the VM. The sub-group of women who used prolonged VMs, hence experienced prolonged apnea episodes, did not experience shorter labor. Therefore, a long expulsive stage was not associated with women using the VM for a short period of time.

There is a disagreement in the literature²¹⁻²³ with respect to the relationship between the type of pushing adopted and the fetal acid-base status and the expulsive stage duration. Group differences across studies and breathing control strategies used to facilitate pushing may contribute to the inconsistency of findings. In a study of 350 women who were primiparas, Parnell et al.²¹ reported no differences in the arterial pH and the base excess when women used VM with open versus closed glottis when pushing during labor. However, the expulsive stage was longer in the group that used the closed glottis with VM and neonates with low Apgar scores at the 1st minute and low arterial pH were observed in this group. Another study reported similar findings when women (primipara and multipara) pushed with either an open or closed glottis²². Several studies^{5,7,23} have compared the 10 seconds VM with spontaneous pushing, where women adopt their instinctively appropriate breathing pattern. However, umbilical blood gases were not evaluated in these studies, and no differences in the duration of the expulsive stage between breathing techniques were found. Caldeyro-Barcia et al.⁸ and Thompson¹⁶ reported a shorter expulsion time in women who used VM, however; umbilical pH was negatively affected.

The Apgar score used in the clinical assessment of newborns at birth is an easy and commonly used tool, however; its objectivity has been questioned²⁴. In this study while umbilical blood gas analysis detected 9 neonates with low arterial pH, the Apgar score at the 1st minute was low only for 4 neonates. Low arterial pH and low Apgar scores were simultaneously found only in two neonates. All neonates exhibited normal Apgar scores at the 5th minute, and there was no association between the VM duration and Apgar score. Reports from related studies have shown inconsistency between the detection of low arterial pH based on gas analysis and the Apgar index^{14,25}. According to the American Academy of Pediatrics¹⁰, hypoxemia

is supported with the detection of metabolic acidemia in umbilical cord blood.

One reason that the uterus fundal pressure maneuver is used during the late expulsive stage is to accelerate fetal expulsion²⁶. A push with a short duration VM reflects a patient's poor willingness to cooperate, thereby showing predisposition to the practice of such conduct²⁷. However, we observed that the pregnant women who used VM of shorter duration did not present a high incidence in the use uterus fundal pressure, indicating that a long VM did not preclude the maneuver to be indicated.

An increase in maternal heart rate was noted during the VM, but there was no relationship between heart rate and VM duration. According to Sherman et al.²⁸, the largest increases in maternal heart rate coincide with an uterine contraction associated with pushing, and autonomically-mediated by the VM. In our study, the fetal heart rate was not recorded. We recommend that this parameter be included in future studies. Pushing in conjunction with a VM has been associated with fetal heart rate changes including prolonged deceleration and bradycardia consistent with a hypoxemic response⁸. These reports confirm the need for greater understanding about normal breathing and pushing efforts in women in labor to guide the development of more refined clinical practice guidelines to support women during childbirth and delivery.

Oxytocin administration was comparable in the two subgroups studied, namely, those who used VMs ≤ 6 s duration vs. >6 s duration, but in 19 women who were administered the drug, 71.4% were in the group whose VMs were greater than 6 s. Similar results were reported by Parnell et al.²¹ where oxytocin tended to be needed by women who adopted a VM with a closed rather than an open glottis. Increases in the efficiency of contractions with oxytocin stimulation lead to an increase in the duration of the VM. Furthermore, ineffective uterine contractions may necessitate prolonged VMs^{21,27}.

The importance of the mother's body position during the expulsive stage of labor should be highlighted. Adverse effects of the supine position on placenta's circulation occur even with a 30° angle between the trunk and legs²⁹. Additionally there is a marked reduction of Lung Functional Residual Capacity with supine position³⁰. The inconvenience of this position during the expulsion has been well established, based on blood flow reduction in the aorta and inferior vena cava caused by uterine compression which increases during a VM-mediated contraction³¹. The absence of an association between VM duration and the position adopted by women who are delivering may be due to the small sample size included in this study. In addition, although women were positioned in either supine or more

upright, these positions were not markedly different given the constraints of the delivery table.

There were no associations between neonatal body weight and VM duration, although it was expected that heavier babies would need longer VMs because they may be prone to compress more the rectum/sacral plexus²¹. The size of the neonate does not appear to elicit longer VMs. In a retrospective study related to the type of push used by women, Sampsel and Hines³² also observed no association between neonatal weight and prolonged VMs.

Our data did not support an association between VM duration and the status of the perineal muscles, because the need for episiotomy in this population was not selective, as there were only 7 women who were multipara who did not require it. Therefore, any comparison could have added methodological bias to the results of the study as episiotomy was associated with number of previous births. Some studies^{4,7,32,33} however have reported that the use of an open glottis is beneficial because it reduces tears and ruptures of the perineal muscles and the incidence of episiotomy, and improves urodynamic indices. This prevents the development of stretch reflex occurring when the muscles are submitted to a sudden and continuous effort such as during a VM⁷. Spontaneous vocalization of women during childbirth could be evaluated in conjunction with maternal and neonatal outcomes of interest in a future study. Because cross cultural differences exist with respect to vocalization during labor, cross cultural studies of these relationships could shed valuable insight into optimal breathing and pushing recommendations.

This study supports that duration of the VM used during the expulsive stage of labor may interfere with blood gases sampled from the umbilical cord. A prolonged VM was not associated with the use of uterus fundal pressure neither shortened the second stage of labor.

These findings convey new information supporting strategies for the use of an open glottis, through vocalization, during the second stage of labor to minimize potential risk, such as hypoxia, to the neonate. Randomized controlled trials with large sample sizes are need to further evaluate VM and open glottis and to enhance the effectiveness of doctors, nurses and physical therapists in assisting delivery.

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