

## Original Article

# Hydration status of pregnant women in West Jakarta

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**Background and Objectives:** During pregnancy, the body exhibits dynamic changes in fluid composition. More than 50% of women experience nausea and vomiting during the first trimester. Studies of hydration status in pregnant women are limited, and not in tropical countries, like in Indonesia. The objective of this study was to investigate the hydration status and appropriate biomarkers for determination of hydration status in pregnant women in West Jakarta. **Methods and Study Design:** This study was cross-sectional. A total of 35 pregnant women aged (19-35 years) at the early second trimester of pregnancy was recruited. Urine osmolality, urine specific gravity, and serum osmolality were used to determine hydration status. Subjects then were divided into a hydration group (HG) and a dehydration group (DG). We used independent *t* tests, chi-square and Spearman rank correlation coefficient to analyse the data. **Results:** The population was comparably divided between dehydration and hydration groups (57.1% and 42.9%, respectively). The proportions by age, parity, gestational age, height, weight, upper arm circumference, waist circumference, pelvic circumference, body temperature, blood pressure, and fundal height did not differ between groups ( $p \geq 0.05$ ). There was a relationship between urine colour and hydration status ( $p < 0.05$ ). Differences in hydration biomarker status (urine osmolality and urine specific gravity) were noted between the groups ( $p < 0.05$ ). **Conclusions:** Dehydration may be common during pregnancy in tropical Indonesia and can be confirmed by the hydration biomarkers of urinary specific gravity and osmolality. Fluid balance is necessary to prevent health problems and intrauterine growth restriction in pregnant women.

**Key Words:** hydration status, urine specific gravity, urine osmolality

## INTRODUCTION

During the gestational period, women exhibits dynamic changes in fluid composition to support fetal development from conception to birth.<sup>1</sup> More than 50% of women have been reported to experience nausea and vomiting during early pregnancy.<sup>2</sup> Other study found these symptoms to affect some 70%–80% of women in the first trimester.<sup>3</sup>

Water is the only essential liquid nutrient for body hydration and health because it ensures that the homeostatic mechanism in the human body functions normally.<sup>4,5</sup> Water accounts for 75% of body weight in infants and 55% in elderly adults; maintaining this level is essential for the cellular homeostasis and life.<sup>6</sup> During pregnancy, the extracellular volume expands, and vasopressin secretion is induced by a shift in plasma osmolality levels to approximately 10 mOsm/kg lower than that in nonpregnant women; however, the metabolic clearance rate of vasopressin is four times higher in pregnant women.<sup>7</sup> During pregnancy, urine osmolality may be unchanged or lower than that observed in nonpregnant women. In fetal sheep, the plasma osmolality is approximately 3–5 mOsm/kg lower than that in ovine ewes. Pregnant women have sufficiently high total body-water content to have the functional status of “hyposmolality.” This ensures euhydration of the fetus (e.g., 88% at the total body mass at a weight of 200 g; 79% at a weight of 2000 g) and causes diuresis

in the mother.<sup>7</sup> Other studies have shown the maternal weight and body water content during pregnancy period to be significantly associated with infant birth weight<sup>8</sup> but not maternal body fat.<sup>9</sup> However, height is unassociated with changes in body water or plasma volume. Women with a low BMI and height during early pregnancy tend to have lower extracellular water and total body water during early, mid, and late pregnancy. This potentially increases the risk of fetal growth restriction.<sup>10</sup> Several indicators of hydration status have been developed, such as urine specific gravity, urine colour, urine osmolality, plasma or serum osmolality,<sup>11</sup> serum sodium<sup>12</sup> and bioelectrical impedance.<sup>13</sup>

In addition to nausea and vomiting during pregnancy, some maternal behaviours including the consumption of alcohol, medication, traditional herbs, and tobacco are problematic. Alcohol consumption during pregnancy remains a major public health problem worldwide. In 1973,

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Manuscript received 26 March 2017. Initial review completed 30 March 2017. Revision accepted 13 May 2017.

doi: 10.6133/apjcn.062017.s14

the Lancet Study confirmed that consuming alcohol while pregnant can cause the fetal alcohol syndrome, which leads to functional abnormalities and serious dysmorphogenesis of the fetal brain.<sup>14</sup> Other studies have confirmed that women who consume alcohol should use reliable contraceptives, plan their pregnancies, or cease drinking before becoming pregnant.<sup>15,16</sup> These studies have confirmed that consuming alcohol during pregnancy can negatively affect the fetus. Other common behaviours that can cause problems during pregnancy include poor diet, hygiene and sanitation, and weight monitoring.<sup>16-18</sup> In addition, sociodemographic characteristics have been shown to be predictors of maternal behaviour.<sup>17,18</sup> Many problematic behaviours affect the health status of pregnant women. For instance, nausea and vomiting during pregnancy influence to the mother's behavior,<sup>19</sup> and the duration and severity of symptoms determine the level of impact on their health status.<sup>20</sup>

The pregnant women who participated in the present study were assessed using a cross-sectional design; thus, considerable variation may have existed. By contrast, gestational age until birth was assessed using a cohort design. Other factors that may have influenced the results are hydration status in the third trimester, dietary intake, water consumption, and micronutrient status in the third trimester until delivery. Using these data, the present study was conducted to investigate the hydration status and appropriate biomarkers to determine the hydration status of pregnant women in West Jakarta. We hypothesised that biomarkers would allow assessment of hydration in pregnant women.

## MATERIALS AND METHODS

This study was a cross-sectional study of hydration status in pregnant women. The study was conducted in the sub-district of Kebon Jeruk, West Jakarta, from December 2016 to February 2017. The study site has the highest number of pregnancies for district-level health care centres in the subdistricts of West Jakarta. Ethical approval was granted by the Ethics Committee of the Faculty of Medicine, University of Indonesia (No. 869/UN2.F1/ETHICS/2016).

The sample of pregnant women in this study comprised pregnant women who visited a health centre in Kebon Jeruk. The total sample are 35 pregnant women with the inclusion criteria were as follows: 1) having received a pregnancy examination at a health centre in the study location; 2) being in the second trimester of pregnancy (>12–24 weeks); 3) being of normal health (e.g., no secondary infections), as determined by the results of a medical examination; 4) never having a low-birth-weight or stunted infant (<48 cm); 5) being aged between >18 and 35 years; 6) having a height of 150–165 cm; 7) having a BMI of 18.5–25.0; 8) having experienced a urinary tract infection, as determined by medical records or a doctor's diagnosis; 9) having experienced diarrhoea, nausea, or vomiting in early pregnancy; 10) planning to deliver in a health centre; 11) having given approval to participate in the study by signing a form of informed consent; 12) being willing to comply with the study procedures; and 13) having never undergone a caesarean delivery.

For this study, dehydration was defined as urine osmo-

lality  $\geq 500$  mOsm/kg, serum osmolality  $>299$  mOsm/kg, urine specific gravity  $>1.015$ , and urine colour score  $>4.0$ . Subjects with positive biomarker values higher than normal or with more than three indicators of hydration were assigned to the dehydration group (DG).

The data collected were the subjects' identity, body weight, body height, fundal height, and blood pressure. Body weight, body height, and fundal height were measured by a midwife and trained enumerators. Weight was measured using a weighing scale and rounded to the nearest 0.1 kg; height was measured using a microtoise stature meter and rounded to the nearest 0.1 cm; and upper arm circumference, waist circumference, and pelvic circumference were measured using a meter line and rounded to the nearest 0.1 cm. Questionnaires about the mother's medical health history and behaviour during pregnancy were administered by trained enumerators with a background in nutrition. Blood and urine were collected in the afternoon (12.00–01.00 pm and 02.00–04.00 pm, respectively) and were analysed at an Accredited Laboratory.

Finally, the hydration status indicators (serum osmolality, urine specific gravity,) were evaluated using blood drawn from the antecubital vein by trained phlebotomists and were measured by sandwich ELISA.

Data analysis was then performed to identify any differences in the baseline characteristics or hydration biomarker between the two groups. The relationships between maternal health characteristics and hydration status were ascertained. The independent Student's *t* test, chi-square and Spearman rank correlation coefficient were used.

## RESULTS

Table 1 shows the characteristics of the participants. The total number of subjects included in the analysis was 20 (57.1%) for the DG and 15 for the hydration group (HG) (42.9%).

The table shows that the groups did not differ significantly when stratified by age, parity, gestational age, height, weight, upper arm circumference, waist circumference, pelvic circumference, body temperature, blood pressure, and fundal height ( $p \geq 0.05$ ) (Table 2). The average of all indicators from the two groups was normal.

The analysis results in Table 2 indicate no significant differences between the maternal health characteristics and hydration status ( $p \geq 0.05$ ). However, 70.0% of the women in the DG experienced nausea and vomiting. The data indicate that persistent vomiting and severe nausea can progress to fluid and electrolyte disturbance. Vomiting has a protective function of ridding the body of viruses, bacteria, or toxins. Prolonged vomiting, however, can cause dehydration, and in some cases, an electrolyte imbalance and even hyperemesis gravidarum. During pregnancy, women can easily experience nutritional deficiencies and weight loss. Thus, to ensure a healthy pregnancy, pregnant women should undergo routine examinations.

Table 2 also shows that half of mothers-to-be readily felt tired or had related symptoms. At the same time, more than 50% of them had a urine colour index more than 4 (dark). This indicator has a relationship between two groups (DG and HG) ( $p < 0.05$ ,  $r = 0.58$ ). The data shows, a pregnant woman who has a dark urine colour, it

**Table 1.** Participant characteristics by hydration status

Variable	DG (n=20)	HG (n=15)	p-value
Age (y)	25.8±4.2 <sup>†</sup>	25.4±3.7	NS
Parity (%)			NS
First	45.0	53.3	
Second	50.0	33.3	
Third	5.0	13.4	
Gestational age (weeks)	7.5±2.2	6.6±1.9	NS
Height (cm)	154±4.3	155±3.8	NS
Weight (kg)	56.5±10.2	57.5±8.9	NS
Upper arm circumference (cm)	26.4±3.3	27.6±3.3	NS
Waist circumference (cm)	88.7±9.7	88.6±6.7	NS
Pelvic circumference (cm)	96.1±7.5	95.8±7.8	NS
Body temperature (°C)	35.8±0.7	35.4±2.5	NS
Blood pressure(mmHg)			
Systolic	108±10.7	110±10.1	NS
Diastolic	72.2±4.8	71.0±0.6	NS
Fundal height	12.8±2.7	13.4±2.5	NS

DG: dehydration group; HG: hydration group; NS: no significant difference.

<sup>†</sup>Mean±SD.

indicates she's under the conditions of acute dehydration<sup>21</sup> and easy to felt dizziness, fatigue and tiredness.<sup>22,23</sup>

Table 3 shows significant differences in urine osmolality and urine specific gravity, between the two groups ( $p<0.05$ ). However, serum osmolality did not differ between the groups ( $p\geq 0.05$ ). These results indicate that the only difference between the groups in the second trimester was in their hydration status.

Three biomarkers of hydration status were used in this study, namely, serum osmolality, urine osmolality, and urine specific gravity. These three biomarkers were correlated with each other. Urine osmolality was highly correlated with urine specific gravity. According to Table 4, urine specific gravity and urine osmolality can be used as standard hydration biomarker in pregnant women ( $p<0.05$ ).

## DISCUSSION

Indonesians remain, as is reasonable, concerned about pregnancy problems. Every pregnant woman is at risk of death; thus, improving the health status of pregnant women until their delivery is one of many attempts aimed at lowering maternal mortality. Hydration is critical to health, especially during pregnancy. In this study, we observed differences in urine osmolality, urine specific gravity, and urine colour between the DG and HG. An indicator of hydration status can be derived by comparing actual urine osmolality with the maximum level.<sup>7</sup> During pregnancy, women experience an increase in body weight; this is not only due to body fat deposition occurring physiologically throughout the pregnancy but also because of an increase in total body water content.<sup>24</sup> Amniotic fluid controls the balance between fluid production and absorption. In women with normal amniotic fluid, maternal oral hydration increases the amniotic fluid index by approximately 16%, whereas fluid restriction decreases the amniotic fluid index by approximately 8%.<sup>25</sup> Maternal fluid volume or osmolality may have a role in maintaining the amniotic volume.

Amniotic fluid is crucial to maintaining fetal well-being; therefore, an amniotic fluid deficiency can cause conditions such as oligohydramnios. This can have multi-

**Table 2.** Maternal health characteristics by hydration status

Variable	DG (%)	HG (%)	p-value
Nausea and vomiting	70.0	46.7	0.163
Dizziness, pale, listless, and tiredness	50.0	53.3	0.845
Painful urination, frequent and less	35.0	46.7	0.486
Urine colour	80.0	20.0	0.001

DG: dehydration group; HG: hydration group.

**Table 3.** Hydration biomarkers of the pregnant women by hydration status

Hydration biomarker	DG	HG
Urine osmolality (mOsm/kg)*	733±266.4	277±153.2
Serum osmolality (mOsm/kg)	306±19.4	302±7.5
Urine specific gravity*	1.02±0.00	1.01±0.00

DG: dehydration group; HG: hydration group.

\* $p<0.05$ , independent *t* test.

**Table 4.** Spearman rank correlation coefficient between hydration biomarkers

Hydration biomarkers	Urine osmolality	Serum osmolality
Serum osmolality	0.38*	1.00
Urine specific gravity	0.86**	0.46**

\* $p<0.05$ ; \*\* $p<0.01$ .

ple impacts on the prognosis of a pregnancy.<sup>26</sup> Pregnant women with oligohydramnios require additional water intake to increase the amniotic fluid volume.<sup>7</sup> Furthermore, pregnancy-induced hypertension can occur, which also requires an increase in amniotic fluid volume through maternal hydration.<sup>27</sup> This discussion shows that water, as one of the six basic nutrients, is essential to health, especially for pregnant women.

Many factors can cause a body fluid imbalance during pregnancy. The most common problem affecting pregnant women in the community is nausea and vomiting. In the present study, no difference was observed between the

mothers' maternal health history and hydration status. However, 70.0% of women in the DG and 46.7% in the HG experienced nausea and vomiting. Nausea and vomiting occur in approximately 80% of pregnant women, and several treatments are available to alleviate the symptoms.<sup>28</sup> Treatments for decreasing nausea and vomiting include pyridoxine, doxylamine (oral or intravenous),<sup>29</sup> proton pump inhibitors, steroids, ondansetron,<sup>28</sup> herbal or alternative medicines<sup>30</sup> such as ginger,<sup>31</sup> and dietary management to minimise symptoms such as eating frequent yet small meals, snacking, and drinking water.<sup>32</sup> If nausea and vomiting during pregnancy are severe and persistent, the condition can progress to hyperemesis, especially in pregnant women who are unable to maintain adequate hydration, fluids, electrolyte balance (homeostasis), and nutrition.<sup>33,34</sup> Moreover, prolonged nausea and vomiting can affect fetal development.<sup>35</sup> Therefore, pregnant women should pay close attention to their food and water intake.

Our results indicate that most mothers have an indicator of urine colour more than 4 (dark colour). Urine colour is a practical indicator that is easy to use for the assessment of hydration status, in children and adult women and men.<sup>36</sup> Urine colour may also alert to other hydration-related disorders such as painful urination, fever, fatigue,<sup>22</sup> and after athletic exercise, especially in the heat.<sup>21</sup> Our findings also show urine specific gravity and urine osmolality to be acceptable hydration biomarkers. Urinary measures are more sensitive in the short term than other measurement methods.<sup>37</sup> Urine osmolality is currently used to assess hydration status in children, women, and athletes.<sup>7,11,38</sup>

### Conclusions

Differences were observed in the hydration biomarker status (urine osmolality, urine specific gravity, and urine colour) between HG and NG, but no differences were noted in serum osmolality. The participants were all apparently health and comparable, as judged by age, parity, gestational age, height, weight, upper arm circumference, waist circumference, pelvic circumference, body temperature, blood pressure, and fundal height. More than 50% of the women experienced nausea and vomiting (70.0% in the HG). Urine osmolality and urine specific gravity can be used as hydration biomarkers in pregnant women. Many factors affect hydration status during pregnancy, and their impact on fetal development should be studied long-term. During pregnancy, body fluid balance is necessary to prevent maternal health problems and intrauterine growth restriction.

### ACKNOWLEDGEMENT

This study was fully funded by the Indonesian Danone Institute Foundation. The views expressed herein are those of the individual authors, and do not necessarily reflect those of the Indonesian Danone Institute Foundation. The authors gratefully acknowledge the contributions of Dr Widjaja Lukito.

### AUTHOR DISCLOSURES

The authors have no conflict of interest to declare.

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