# Hydration status count for weight gain on pregnancy period

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# Hydration status count for weight gain on pregnancy period



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## Abstract

**Purpose** – In Indonesia, 29.3% of Indonesian women were obese. Dehydrated women have 1.6 times higher risk of becoming obese than normal ones. This study was aimed to further explore the association between gestational weight gain (GWG) and maternal hydration status.

**Design/methodology/approach** – This longitudinal study involved 50 pregnant women aged 18–35 years. Subject identity, age, parity and household expenses were collected using questionnaire. Urine specific gravity (USG) was used as an indicator for hydration status. Venous blood was collected to measured haemoglobin (Hb) by anemometer method. Anthropometric data such as pre-pregnancy weight, maternal body weight, GWG, body mass index (BMI) and mid-upper arm circumference (MUAC) was collected using standardized tools. Dietary and total water intake (TWI) were measured through three consecutive days of a 24-h food recall. Pearson's correlation, independent *t*-test and analysis of covariance were used to appraise the hypothesis.

**Findings** – The subject's mean age was 29.3 ± 5.6 years; BMI was 23.5 ± 4.1 kg/m2. MUAC (28.2 ± 4.0 cm) and Hb (11.5 ± 1.0 g/dl) were still in the normal range. Most subjects were well hydrated, with an average USG of 1.016 g/mL. GWG and TWI are significantly correlated ($p < 0.01$). Based on the hydration status, after corrected with TWI, GWG was not significantly different.

**Originality/value** – It calls to mind that nutrition and water intake, alongside weight gain monitoring during pregnancy, are part of an effort to prevent pregnancy risks.

**Keywords** Hydration status, Gestational weight gain, Pregnancy

**Paper type** Research paper

## Introduction

Overweight is defined as a condition in which the body mass index (BMI) exceeds 25.0 kg/m$^2$, whereas obesity occurs when the BMI is ≥30.0 kg/m$^2$ (World Health Organization, 2000). In Indonesia, there was an increase in the prevalence of obesity in pregnant women from 2004 to 2014, 22.1% to 28.3%, respectively. A similar increase can also be found in other countries such as the Philippines, India, China and others (Chen *et al.*, 2018). Furthermore, according to the RISKESDAS (Indonesian Basic Health Research) 2018, the prevalence of obese women has reached 29.3% (Ministry of Health of the Republic of Indonesia, 2019). A study conducted in 2018 also showed that 60% of women who were obese had an excess gestational weight

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gain (GWG) when compared to the recommendation of the USA's Institute of Medicine (IOM) (Goldstein *et al.*, 2018).

Excessive GWG and obesity are associated with comorbidities such as diabetes, hypertensive disorders and preeclampsia. Maternal obesity can also increase the risk of large-for-gestational age, macrosomia, miscarriage and caesarean delivery (Stubert *et al.*, 2018; Wang *et al.*, 2019). Some of the factors that influence weight gain during pregnancy are preconception BMI, energy intake and physical activity. Women with a preconception BMI of $\geq$25.0 kg/m$^2$, excessive energy intake and low physical activity tend to experience excessive GWG (Ebrahimi *et al.*, 2015). Parity, defined as the number of pregnancies with gestational age $\geq$20 weeks that have occurred in a decade, was also positively associated with preconception BMI and weight gain during pregnancy (Hill *et al.*, 2017). Parity was also correlated with pregnancy complications, neonatal morbidity and perinatal mortality (Power *et al.*, 2018).

A study found that in dehydrated non-pregnant women, a relationship between hydration status and BMI was shown. Dehydrated women had 1.6 times higher risk of being obese than the hydrated ones (Chang *et al.*, 2016). This phenomenon may occur because water consumption at meals can provide fullness, so that someone who drinks a little (likely to becomes dehydrated) will feel hungry more quickly and eat more often than people who frequently drink water (Parretti *et al.*, 2015). Another study conducted on mice showed that increasing water intake or adequate hydration could help with weight loss. It was assumed that increasing water intake could increase the metabolic rate, leading to increased mitochondrial function, resulting in lipolysis in adipose tissue (Thornton, 2016). Besides, optimal water intake can also optimize foetal growth, therefore minimizing the risk of low birth weight (Wright *et al.*, 2010)

Maternal nutritional status is one factor that plays a vital role in the health of the mother and foetus during pregnancy. Optimal intake of energy and nutrients is needed to ensure optimal nutritional status as well. Apart from energy intake, water intake can also affect nutritional status and maternal weight during pregnancy. To our knowledge, no study has examined the relationship between hydration status and GWG. Therefore, this study was aimed to further explore the association between GWG and maternal hydration status.

## Materials and methods

*Study design*

This longitudinal cohort study was conducted from March 2019 to November 2019 at the Public Health Centre of Kebon Jeruk District, West Jakarta. The selection of location was determined based on the number of antenatal care visits, around 150 visits per day and the fact that it was the pilot and reference health centre for the West Jakarta area. This research has received ethical approval from the Esa Unggul University Health Research Ethics Commission, Jakarta, in the form of an Ethical Approval Statement with the number: 0119–19.114/DPKE-KEP/FINAL-EA/UEU/V/2019 dated 15 May 2019.

*Subject*

The subjects in this study were pregnant women at the beginning (8–12 weeks) to the end of the trimester (28–38 weeks) who came to have their pregnancy checked in the study area during the study period. Subjects were taken using the purposive sampling method (non-probability sampling). The inclusion criteria for the subjects were:

- pregnant women getting their antenatal care at the research health centre;
- healthy (not suffering from secondary infections) based on the medical examination;

- never gave birth to low birth weight and short babies;
- 18-35 years old (18 being the minimum age for marriage in Indonesia; 35 being the maximum ideal age for pregnancy [American College of Obstetricians and Gynecologists Committee on Gynecologic Practice and Practice Committee, 2014]);
- have a body height of 150–165 cm;
- have a normal BMI (18.5–25.0 kg/m$^2$);
- signed the informed consent; and
- willing to comply with the research procedures.

First, 110 pregnant women were identified (8–12 weeks), and ten were excluded. The first data from 100 subjects were collected, and in the end, 50 subjects (28–38 weeks) were picked as the subsample for the observational stage, where biomarker data were collected. Thus, the number of subjects met the required minimum sample size. The data collection flow is presented in Figure 1.

*Data collection*

Interviews and questionnaires were used to collect data such as subject identity, age, parity and household expenses. Pre-pregnancy weight and first trimester (8–12 weeks) body weight taken from the *Maternal and Child Health Record Book* (*Buku Kesehatan Ibu dan Anak* [KIA Book]). Meanwhile, the second (16–20 weeks) until last trimester (28–38 weeks) body weight and GWG were measured by Omron digital weighing scale with an accuracy of 0.1 kg; GWG was calculated as the difference between weight at delivery and the

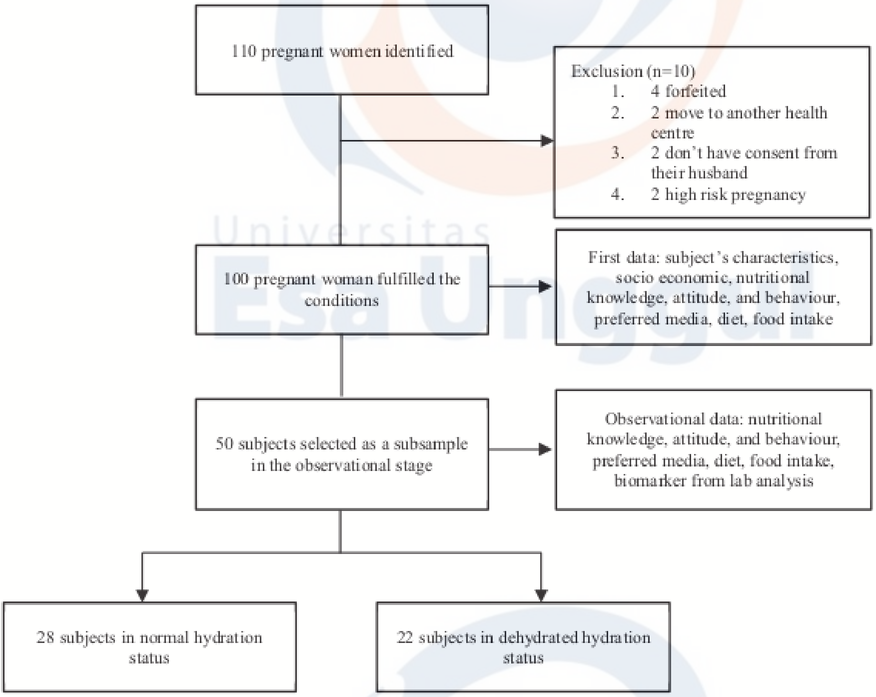


**Figure 1.**
Data collection flow

pre-pregnancy weight. Mid-upper arm circumference (MUAC) was measured using a meter line with an accuracy of 0.1 cm from the first until the end of trimester, where measurement below 23.5 cm will be considered as at risk having chronic energy deficiency, according to the Ministry of Health Republic of Indonesia Guideline (Harjatmo, 2017). Height was measured using a microtoise with an accuracy of 0.1 cm. Well-trained nutritionists executed all these measurements under the close supervision of the researcher. Blood and urine were collected in the afternoon (spot urine) (12.00–01.00 p.m. and 02.01–04.00 p.m., respectively) (Bottin *et al.*, 2016) during the antenatal care visit, at the third trimester (Malisova *et al.*, 2014) and were analysed at an accredited laboratory near the study site. The urine specific gravity (USG) was measured using the sandwich enzyme-linked immunosorbent assay method, whereas the haemoglobin (Hb) level was examined using the anemometer method assisted by trained phlebotomists. A USG cut-off value of $\geq$1.013 has proven to be accurate (sensitive and specific) in detecting urine osmolality of $>$500 mOsm/kg. Urine osmolality of $\leq$500 mOsm/kg has been proposed as a reasonable target for urine concentration that reflects sufficient total water intake (TWI) (Perrier *et al.*, 2017). Another study by Armstrong *et al.* (2012) also stated that a well-hydrated woman exhibits a USG of $<$1.016. Thus, USG of $<$1.015 appears to be a reasonable and accurate cut-off value indicating a well-hydrated condition in this study. Normal Hb level was considered as 11 gr/dL or higher, according to the World Health Organization guideline (World Health Organization, 2011).

Nutritional intake data were taken using 24-h food recall interviews for three consecutive days (one-day weekend and two-day weekdays) in the second and last trimester and collected by well-trained enumerators. The nutritional intake data were then converted into energy (kcal), protein (g), fat (g), carbohydrates (g), fibre (g) and water (mL) intake using the Nutri-Survey application program. Water intake data was obtained by calculating the amount of fluid consumed by the subject using 24-h recall interviews as stated before, both from drinks and food. TWI came from water metabolic, mineral water, food and other water (with additional colour or taste).

*Data analysis*

The study population size during the COVID-19 pandemic was 50 pregnant women who visited the health centre, which was based on the sample proportion calculation. Using alpha/2 (1.96), a minimum sample of 44 pregnant women was obtained as the sampling unit in the study area. Furthermore, using the prospective cohort formula in which the degree of strength (power) is 80.0% – with the assumption of the subject dropout rate of 20.0% and dtandard deviation (S.D.) for urine specific gravity is 0.001 (Mulyani *et al.*, 2017) – a minimum sample of 48 was obtained. Researchers performed an initial screening of subjects in the early trimester of pregnancy.

The research variables in the form of subject characteristics, biomarker data, weight gain, nutritional status, nutrient intake and water were tested for normality by the Kolmogorov-Smirnov test ($p > 0.05$) and normal distribution curves before hypothesis testing. Maternal age, MUAC, pre-conception body weight, maternal body weight, body height, BMI, GWG, Hb, USG, household expenditure, parity and hydration status based on USG were described by the frequency distribution value $n$ (per cent) and mean ± S.D. The relationship among GWG and nutritional intake (energy, carbohydrate, fat, protein, fibre and water intake), parity and economic factor was appraised using Pearson's correlation test ($p < 0.05$). Independent *t*-test ($p < 0.05$) was used to assess the differences of nutritional intake (energy, carbohydrate, fat, protein, fibre and water intake), parity, monthly living expenses and GWG between hydrated and dehydrated group. Analysis of covariance (ANCOVA) ($p < 0.05$) was performed to weight the water intake on the effect of hydration status on GWG.

## Results

The characteristics of subjects related to their age, nutritional status, parity, household expenditure and hydration status based on USG are presented in Table 1. The subject's mean age was still considered an ideal reproductive age (20–30 years old) (Prihatini and Rahayu, 2016). The mean pre-pregnancy weight and the subject's average BMI was normal (23.5 ± 4.1 kg/cm$^2$), based on the guideline from the Indonesian Ministry of Health (Directorate General of Public Health, 2003).

Based on the subject's BMI, we found about 50.0% had excessive GWG, referring to the IOM recommendation of a 12.8 kg weight gain. At the second trimester, MUAC and Hb were still in the normal range (28.2 cm and 11.5 g/dl, respectively), and about 40% of the pregnant women were multiparous (having parity of ≥2). The mean monthly household expenditure was Indonesian Rupiah (IDR) 4,218,529; if we were to divide it into five categories based on quintiles, there were < IDR 3,065,199 (lower income), IDR 3,065,199–3,891,700 (lower middle income), IDR 3,891,701–4,578,293 (middle income), IDR 4,578,294–5,955,875 (upper middle income), > IDR 5,955,875 (high income), the mean would be in the middle category. Meanwhile, the average household expenditure in this study was still above the average monthly household expenditure in Jakarta (IDR 2,257,991) (Khoer, 2020).

The maternal hydration status was determined by the USG measurement. Mean maternal USG was 1.016 with more than half of them (56.0%) were well-hydrated. Nevertheless, considering the cut-off point used in this study (1.015), the maternal USG results were considered as mildly dehydrated. Table 2 demonstrates the correlation between the risk factor of hydration and GWG. High TWI ($r$ = 0.65) were positively associated with GWG. It is assumed that households with better income will most likely reach the maternal nutritional needs.

| Variables | Mean ± S.D. | $n$ (%) |
|---|---|---|
| Mother's age (y) | 29.3 ± 5.6 | |
| MUAC (cm) | 28.2 ± 4.0 | |
| Pre-conception body weight (kg) | 56.4 ± 7.3 | |
| First trimester body weight (kg) | 57.0 ± 7.6 | |
| Second trimester body weight (kg) | 62.8 ± 8.5 | |
| Third trimester body weight (kg) | 68.5 ± 8.7 | |
| Body height (cm) | 158 ± 4.1 | |
| Body mass index (kg/m$^2$) | 23.5 ± 4.1 | |
| Gestational weight gain (kg) | 14.8 ± 4.0 | |
| Haemoglobin (gr/dL) | 11.5 ± 1.0 | |
| Urine specific gravity | 1.016 ± 0.5 | |
| Monthly living expenses (IDR) | 436,963 ± 335,218 | |
| Parity: | | |
| • 0 | | 20 (40) |
| • 1 | | 10 (20) |
| • 2 | | 12 (24) |
| • ≥3 | | 8 (16) |
| Hydration status: | | |
| a.Hydrated (USG <0.015) | | 28 (56) |
| b.Dehydrated (USG ≥0.015) | | 22 (44) |

**Notes:** Abbreviations: S.D.: standard deviation; MUAC: mid-upper arm circumference; IDR: Indonesian rupiah; USG: urine specific gravity

**Table 1.** Demographic and anthropometric characteristic of pregnant women ($n$ = 50)

The comparison between maternal dietary intakes, including the TWI, GWG and hydration status based on USG, is presented in Table 3. There was a significant difference between TWI ($p < 0.01$) and GWG ($p < 0.01$) across the hydration status. Well-hydrated mothers had a higher mean of TWI and GWG when compared to the dehydrated. However, after we corrected GWG using the ANCOVA, we found there were no effects of hydration status on the GWG, as shown in Table 4.

## Discussions

This study examined the association between weight gain and water intake during pregnancy with maternal hydration status. We found that there was a relationship between weight gain and water intake. In this case, water intake affects weight gain during pregnancy. Weight gain during pregnancy and the pre-pregnancy maternal nutritional status are determinants of pregnancy output (Chen *et al.*, 2020). Excessive GWG is a risk factor for gestational hypertension, gestational diabetes mellitus, macrosomia, preterm birth, preeclampsia and caesarean delivery (Wu *et al.*, 2020). During pregnancy, maintaining a nutritionally balanced intake is essential to achieve optimal fetal growth, including water and electrolyte balance in the body. Water balance in the body could cause several issues in pregnancy, such as amniotic fluid imbalance, imbalance of serum sodium and potassium, which disrupts the oxygen pump to the heart, while may also cause oedema and preeclampsia (Stanhewicz and Kenney, 2015; Wang *et al.*, 2019).

**Table 2.** Analysis of nutritional intake, parity and economy factor with GWG among pregnant women ($n = 50$)

| Variables | Mean ± S.D. | r | $p$-value |
|---|---|---|---|
| Energy (kcal) | 2633 ± 577 | 0.01 | NS |
| Carbohydrate (g) | 351 ± 88.5 | −0.07 | NS |
| Fat (g) | 92.9 ± 41.5 | 0.15 | NS |
| Protein (g) | 92.6 ± 36.9 | 0.04 | NS |
| Fibre (g) | 15.9 ± 6.1 | 0.07 | NS |
| Total water intake (mL) | 2389 ± 604 | 0.65* | <0.01 |
| Parity | 2.2 ± 1.3 | −0.04 | NS |
| Monthly living expenses (IDR) | 436,963 ± 335,218 | 0.26 | NS |

**Notes:** Abbreviations: GWG: gestational weight gain; S.D.: standard deviation; IDR: Indonesian rupiah; NS: non-significant. Pearson's correlation test, $p < 0.05$; *positively associated

**Table 3.** Differences in nutritional intake and GWG based on hydration status among pregnant women ($n = 50$)

| Variables | Hydrated (USG <0.015) ($n = 28$) | Dehydrated (USG ≥0.015) ($n = 22$) | $t$-value | $p$-value |
|---|---|---|---|---|
| Energy (kcal) | 2621 ± 574 | 2647.± 594 | −0.16 | NS |
| Carbohydrate (g) | 338 ± 88.2 | 367 ± 88.1 | −1.15 | NS |
| Fat (g) | 99.0 ± 42.7 | 85.1 ± 39.5 | 1.17 | NS |
| Protein (g) | 92.2 ± 41.0 | 93.2 ± 31.8 | −0.09 | NS |
| Fibre (g) | 15.7 ± 6.8 | 16.1 ± 5.1 | −0.22 | NS |
| Total water intake (mL) | 2651 ± 333 | 2104 ± 392 | 5.32 | <0.01 |
| Gestational weight gain (kg) | 17.8 ± 2.8 | 11.1 ± 0.9 | 10.7 | <0.01 |

**Notes:** Abbreviations: GWG: gestational weight gain; USG: urine specific gravity; NS: non-significant. Data are presented as mean ± S.D. (standard deviation). $t$-test; $p < 0.05$

The mean age of the subjects still falls under the category of reproductive age. The pre-pregnancy nutritional status was also in the normal category according to the Health Department of Republic of Indonesia (2003). According to the IOM, with this category, it is expected that the mother's weight gain during pregnancy is 12.8 kg. Based on the study results, it was found that 40% of pregnant women were multiparous, and mean GWG of 14.8 kg was also found, which falls in the excessive category according to IOM. Similar results were also found in several other research, suggesting that parity and pre-pregnancy nutritional status could affect GWG. Generally, multiparous mothers had a nutritional status (BMI) of 25.0–29.9 and $\geq$30.0 kg/m$^2$ (overweight and obese category, respectively) (Paulino *et al.*, 2016; Simko *et al.*, 2019).

However, GWG is also influenced by other factors such as socio-economic, nutritional intake, behaviour, knowledge and others (Dolatian *et al.*, 2020; Suliga *et al.*, 2018). This could be explained by the fact that the purchasing power towards food products could change the behaviour to consume a particular food (Forbes *et al.*, 2018; Goodarzi-Khoigani *et al.*, 2018).

This study found that dehydrated mothers tend to have a higher GWG than hydrated mothers, even though it was not statistically significant. This shows the critical role of water in the process of metabolism during pregnancy. Cellular hydration plays a role in maintaining fluid balance, body temperature, blood pressure, hormonal balance and absorption of nutrients by making it easier for nutrients to enter cells before finally being excreted as metabolic waste. During pregnancy, there is metabolic stress, and cellular hydration helps the reduction of the oxidative stress that predominates (Moreli *et al.*, 2014; Roh *et al.*, 2016).

Other studies also indicated that optimal water consumption could result in body weight loss, especially in a diabetic or overweight person, reducing appetite. This mechanism is related to thermogenesis, gastrointestinal organ distension and changes in osmolality (Vij and Joshi, 2014; Garcia *et al.*, 2019). Other studies have also suggested that drinking water from a weight management perspective has beneficial effects, namely, lowering energy intake, increasing energy expenditure and increasing fat oxidation. These effects were more pronounced in those who consume water more than 1 L per day, while also accompanied by physical activity and suitable dietary arrangements (Dais and Alias, 2018; Most *et al.*, 2018). Thus, it is essential to focus our attention on nutrients and water intake during pregnancy, which can help the metabolic processes while also achieving optimal fetal growth and development.

However, the limitation of this study is that only the biomarker for the hydration status in the third/last trimester can be collected because of the lack of funds. As hydration is a dynamic and complex balance; i.e. constantly changing in regards to several other variables such as drinking intake, solid food intake, disease (diarrhoea, vomiting, fever and burn), drugs, water loss (urine, faeces, sweat and breathing), physical and mental activities, thirst

**Table 4.** Hydration status impact on GWG among pregnant women ($n$ = 50)

| Variables | Hydrated (USG <0.015) ($n$ = 28) | Dehydrated (USG $\geq$0.015) ($n$ = 22) | $p$-value |
|---|---|---|---|
| Before corrected by TWI | | | |
| GWG (kg) | 17.8 ± 2.8 | 11.1 ± 0.9 | <0.01* |
| After corrected by TWI | | | |
| GWG (kg) | 11.8 ± 5.2 | 12.4 ± 6.9 | NS** |

**Notes:** Abbreviations: GWG, gestational weight gain; TWI, total water intake; USG, urine specific gravity; NS, non-significant. Data are presented as mean ± S.D (standard deviation). **t*-test; $p < 0.05$. **analysis of covariance (ANCOVA), $p < 0.05$, $r^2 = 0.004$

sensation, availability of water, weather and humidity, a daily variation is expected. Therefore, it is recommended to collect the biomarker data every trimester to better achieve precise hydration status data throughout the pregnancy period. Furthermore, a combination of several methods in measuring hydration status should be applied for a higher level of precision, for example, through body mass measurement, blood tests, urine tests and saliva flow rate (European Hydration Institute, 2018).

## Conclusion

This study found that maternal hydration status was in the category of mild dehydration on average, with TWI below 3 L per day as recommended by the IOM. There was a positive relationship between water intake and GWG. Furthermore, this study found that the GWG, based on hydration status, was not significantly different. However, there was a tendency for dehydrated mothers to have a higher GWG than the well-hydrated counterparts. It is vital for pregnant women to consume water about 3 L daily, as TWI may affect GWG and the pregnancy outcome later. This study suggests to improve the maternal knowledge of nutrition and hydration during pregnancy through antenatal care optimization; educating pregnant women on the importance of hydration during pregnancy. In addition, we suggest investigating the feasible biomarker, which is inexpensive and user friendly for health workers in the field. Lastly, due to the limitation of this study, a more extensive study on the biomarkers of hydration is needed to provide a better understanding the dynamics of maternal hydration status.

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