Chapter 6
Concluding remarks

Fundal height measurements in centimeters can be used as a primary screening tool to monitor fetal growth and screen abnormal intrauterine growth before ultrasound procedures in both developed and developing countries.[1-6] However, the screening ability may depend on many factors such as FH growth chart used as the screening tool, pattern of FH measurement and criteria for abnormal screening.[7-10] According to a related study from 10-20 years ago, healthcare providers can improve the ability of FH measurement in centimeter to detect abnormal intrauterine growth by creating devices that suit particular characteristics of each population and where normal norms used by a normal population is not applicable, plots FH in centimeters on suitable standard FH growth curve can be performed in every antenatal care visit. In addition, Improvements can be made by frequent standardization of FH measurement methods, creating proper guidelines to screen and further investigation.[1, 2, 11-13]

In Thailand, healthcare providers use FH measurement as a primary screening tool in routine antenatal care practices, FH in centimeters equals to GA in week ±2, instead of using FH growth chart for screening abnormal conditions. In upper northern Thailand healthcare providers also use FH in centimeters equals GA in week ±2 and no standard exists for FH growth curves for Thai pregnant women. Therefore, this thesis emphasized 3 points. First, to create standard FH growth curves for Thai pregnant women who have routine antenatal visits and deliver in Ministry of Public Health Hospitals, upper northern Thailand based on fundamentals of gestational age calculation using LMP or ultrasound according to routine practices to explore primary tools and set criteria that can screen abnormal intrauterine growth for Thai women from 20 to 40 weeks of gestation. Second, to create FH growth curves for pregnant women who are underweight, overweight and obese because of their different FH growth curves which are dissimilar to normal weight. Thus, this will enhance effectiveness of monitoring fetal growth and screening abnormal conditions for underweight, overweight and obese pregnant women. Third, to investigate the FH growth curve patterns of pregnant women with term LBW infants and use as guidelines for monitoring the growth of the fetus and screen SGA fetus and term LBW infants.

A standard FH growth curve for Thai women[14] was derived from FH in centimeters of normal Thai pregnant women who had routine antenatal visits and delivered in Ministry of Public Health Hospitals, upper northern Thailand including 4 settings, i.e., 2 secondary care hospitals and 2 tertiary care hospitals where gestational age was confirmed by ultrasound before 20 weeks. When gestational age by LMP and ultrasound both related, it was calculated using LMP. If not, it was calculated by ultrasound. The result revealed that FH increased from 19.1±1.9 cm at 20 weeks to 35.4±2.4 cm at 40 weeks, and 1.0 cm/wk from 20 to 32 weeks, 0.7 cm/wk from 33 to 36 weeks and 0.3 cm/wk from 37 to 40 weeks. A quadratic regression equation was; FH (cm) = -19.7882 + 2.438157 GA (wk) - 0.0262178 GA^2 (wk) (R-squared=0.85). This equation was used to predict the 10th, 50th, and 90th percentiles of FH and applied to smooth each percentile line. The FH growth curve was presented as a smoothed function of the 10th, 50th, and 90th percentiles between 20 and 40 weeks. It differed from related studies in the aspect of value of FH in centimeters, slope, and curve pattern. These could be due to

differences in race and ethnicity, nutritional status, FH measurement method, gestational age calculation, data collection, and statistical analysis. It demonstrated that each population should have its own FH growth curve for monitoring fetal growth and screening abnormal intrauterine growth.

Subgroup analysis showed that pregnant women who were underweight, had prepregnancy BMI <18.5 kg/m^2, and were overweight or obese, BMI ≥25.0 kg/m^2, had different FH in centimeters from normal weight, BMI 18.5-24.99 kg/m^2. Therefore, the specific FH growth curves for 3 groups of pregnant women were created.[15] The result revealed that the 50th percentile line of the underweight women was 0.1-0.4 cm below the normal weight at GA 23-31 weeks and 0.5-0.8 cm at GA 32-40 weeks. The overweight and obese women line was 0.1-0.4 cm above the normal weight at GA 22-29 weeks and 0.6-0.8 cm at GA 30-40 weeks. It demonstrated that FH growth curves of these women differed. In monitoring and screening abnormal intrauterine growth in underweight and overweight or obese pregnant women, FH growth curves specifically developed for such women should be applied. This may reduce an over- or under-investigation as a consequence of the inappropriate application of FH growth curve for normal weight pregnant women.

During the study period, a total of 2,351 pregnant women attended an antenatal clinic and delivered in the 4 settings. In total, 75 eligible subjects (3.2%) delivered term LBW infants (<2,500 g). FH in centimeters of eligible subjects were plotted on standard FH growth curves for Thai women every antenatal visit throughout pregnancy. Six patterns of FH growth curve emerged, i.e., Pattern I: FH below or around the 10th percentile throughout pregnancy (22.7%), Pattern II: FH below normal in early, reaching up to a normal, after that slowing or static or decreased (25.3%), Pattern III: FH normal in early, then slowing or static or decreased (22.7%), Pattern IV: FH normal in early, then slowing or static or decreased and reaching up to normal (8.0%), Pattern V: FH normal throughout pregnancy except for the last visit (8.0%), and Pattern VI: FH normal throughout pregnancy (13.3%).[16] It showed that the patterns of FH growth curves found among pregnant women with term LBW infants may be used to detect pregnant women who tend to deliver term LBW infants from early pregnancy to the day of admission for delivery. This screening may detect up to 80% of future term LBW infants. Thus, it might be used as guidelines or a primary tool to monitor and screen for term LBW infants, from early pregnancy.

In conclusion, the result of this thesis suggested that between 20 and 40 weeks of gestation a demographically specific FH growth curve based on routine antenatal care practices was an appropriate tool for monitoring and screening abnormal intrauterine growth for Thai pregnant women in upper northern Thailand, rather than FH in centimeters equals to GA in week ±2 because FH in centimeters did not increase linearly according to GA that was increased throughout pregnancy. Normal weight pregnant women could use standard FH growth curve for Thai women based on all normal populations as a screening tool. However, underweight, overweight, or obese pregnant women were recommended to use specific FH

growth curve that were suitable to their prepregnancy BMI. The process of monitoring and screening were performed by plotting FH in centimeters on FH growth charts every antenatal visits. A referral for investigation was made when 1) FH below the 10th percentile line or above the 90th percentile line or 2) pattern of FH slowed down, became static, decreased or increased dramatically.

Standard FH growth curve for Thai women and specific FH growth curve for underweight, overweight and obese pregnant women in a Thai population can be used as a primary tool to screen and follow-up the growth of the fetus at every level of care from primary to tertiary care. However, this work has some limitations due to the retrospective data collection design and generalizability to setting or other contexts where characteristics of pregnant women, FH measurement method and gestational age calculation were differed. The setting involved with pregnant women including varieties of races might need to create specific FH growth curves based on their ethnicity.

Jirawan FH growth curve, the initiated demographically specific FH growth curve, was developed based on the upper northern Thailand population characteristics. Currently, Maharaj Nakorn Chiang Mai Hospital is using the Jirawan FH growth curve as a primary screening tool in the antenatal clinic. However, validation of this curve to determine the effectiveness in clinical setting should be further study. Moreover, the FH growth curve may need to be updated in the future regarding the change in maternal nutrition and socioeconomic status.

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