TYT Curve: Pilot Study on Alternatives Standards of Reference to Determine Intrauterine Growth in Low Resource Setting in Indonesia

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Abstract

Objective: To develop a new intrauterine growth curve based on local population for accurate intrauterine growth retardation (IUGR) infant identification.

Methods: An observational analytic method was applied to develop Tina-Yessika-Tetty (TYT) curve derived from 13,405 neonatal anthropometric measurements taken from the medical record database of Dr. Hasan Sadikin General Hospital, Bandung, Indonesia. The infants included in this study were born during the period of January 1st, 2005 to December 31st, 2009. The new curve was then compared to the Lubchenco and Alisjahbana curves. Only 6,814 data met the inclusion and exclusion criteria.

Results: The mean birth weight in this study was lower compared to that of the Lubchenco and Alisjahbana studies. Comparison of the three curves showed that there was a significant difference among the three curves (R=0.998, R^2=0.996, $p<0.001$), which indicates a probability for a new newborn classification.

Conclusions: TYT curve may be used as an alternative to identify IUGR immediately after birth, especially when detection during pregnancy is not available in low resource setting. A prospective study with a larger population is needed; However, this study has provided an evidence to support the need for timely evaluation for such growth chart as they change over time.

Keywords: Alisjahbana curve, intrauterine growth, Lubchenco curve, TYT curve

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Introduction

Infant mortality is still considered to be one of the major health problems in Indonesia. In 2010, data from Statistics Indonesia show that the infant mortality rate (IMR) in this country was 26.89 per 1000 live births in 2010.[1] This rate is higher than the rate targeted in the Millenium Development Goals (MDGs), which is 23 per 1,000 live births by year 2015.[2] Infant deaths related to low birth weight comprised around 11.5% from all births, mainly caused by intrauterine growth restriction (IUGR) with a prevalence of about 4.4%.[3–7] The IUGR was also considered to be responsible for 26% of stillbirths and may increase infant mortality and morbidity by 7 to 8 times.[8] Some IUGR related morbidities are also found later in life such as hypertension, coronary heart disease, diabetes mellitus type 2, obesity, osteoporosis, and metabolic syndrome.[8–14] For that reason, IUGR prevention, early detection, and appropriate management are required, which starts with the intrauterine growth evaluation.[15] The gold standard for IUGR diagnosis is serial ultrasonography throughout pregnancy, but it is not evenly accessible to all patients.[6,16] An indirect method by plotting newborns anthropometric measurement into a growth curve is considered more suitable for use in population, providing that the intrauterine growth curve is kept 'current'. The Lubchenco curve is still used as the standard in Indonesian hospitals. This curve was developed in American population, which leads to a situation where the genetic differences may inhibit its suitability to be used for other population.[17,18] Many researchers kept updating intrauterine growth curve for their population, including those in United States, which is the country of origin of

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the Lubchenco curve.[19–21] Alisjahbana et al.[22] had developed an intrauterine growth curve for the Indonesian population.[23] Since the curve was dated in 1994, the changes in fetal growth rate may limit its suitability for current use. Therefore, consequently, a new curve should be developed based on our population. Therefore, this study aimed to develop a new intrauterine growth curve based on our population to make identifications of IUGR babies more appropriate.

Methods

Data for this study were retrieved from the Child Health Department and Obstetrics Department of Dr. Hasan Sadikin General Hospital, Bandung for the anthropometric measurement and maternal complications, respectively, during the period of January 1st, 2005 to December 31st, 2009. Dr. Hasan Sadikin General Hospital, Bandung is the top referral hospital in West Java; therefore, the subjects came from surrounding areas in West Java. Inclusion criteria were live birth, singleton pregnancy, and precise menstrual period of the mother. The exclusion criteria were gestational age less than 34 weeks and/or more than 42 weeks, since data from these gestational age periods were not available in any of Lubchenco or Alisjahbana studies. Infants with congenital defect, maternal IUGR-related complication of pregnancy such as hypertension, tuberculosis, diabetes mellitus, hepatitis B infection, cardiac defect, anemia, and high fever. Cases with missing data were also excluded.

The gestational age was calculated from the

Table 1 Study Subjects Characteristics

Criteria	Male		Female		Both	
	n	%	n	%	n	%
Live birth	3,610	53.0	3,204	47.0	6,814	100
Gestational age (weeks)						
28–36	335	4.3	294	4.9	629	9.2
37–42	3,275	42.7	2,910	48.1	6,185	90.8
Birth weight (grams)						
<1,000	0	0	0	0	0	0
1,000–2,499	355	5.2	367	5.4	722	10.6
2,500–3,999	3,206	47.1	2,819	41.4	6,025	88.4
≥4,000	49	0.7	18	0.3	67	1.0

Table 2 Male Birth Weight Percentiles by Gestational Age

GA	n	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	Mean	SD
34	68	1,632	1,750	1,935	2,300	2,786	2,371	530.7
35	105	1,723	1,900	2,200	2,450	2,858	2,523	506.0
36	162	1,942	2,100	2,459	2,750	3,135	2,786	508.9
37	393	2,250	2,400	2,630	2,900	3,250	2,941	438.7
38	678	2,330	2,500	2,750	3,013	3,275	3,011	387.7
39	897	2,418	2,600	2,850	3,125	3,400	3,127	405.4
40	830	2,500	2,656	2,900	3,200	3,488	3,187	398.7
41	322	2,600	2,730	2,994	3,220	3,470	3,223	367.9
42	158	2,499	2,600	2,904	3,200	3,450	3,185	400.8

maternal first day of the last menstrual period to the date of birth. Scattered plot graphics for every newborn were then further developed to create the Tina-Yessika-Tetty (TYT) curve model. The mean birth weight was calculated for each gestational age group and sex. Identification of IUGR based on the three curves under study was then carried out.

Results

There were 13,405 newborns recorded during the selected period consisting of 7,067 male and 6,338 female newborns. Exclusion from this study were done for the following reasons: 51 cases of missing data, 754 stillbirths, 2 infants with sexual ambiguity, 522 with uncertain maternal last menstrual period, 540 multiple gestations, 2,000 cases of possible congenital anomalies, and 2,111 cases of IUGR-related maternal complications leading to a total inclusion of 7,425 newborns, i.e. 3,924 male and 3,501 female infants.

Outliers during statistical analysis were ruled out leading to 6,814 clean data (50.83% of original data) with 3,610 male infants (52.98%) and 3,204 female infants (47.02%).

The characteristics of the subjects show that most of the newborns had a gestational age of 37 to 42 weeks and a weight of between 2,500 and 3,999 grams (Table 1).

The 10th, 25th, 50th (median), 75th, and 90th percentile as well as the mean and SD birth weights for male, female, and both sex infants are presented (Table 2, 3, and 4). A final weight-for-gestational age curves for female and male infants were then created (Fig. 1).

The crude curves show some “bumps” in several percentiles, leaving some assumptions that some truly term births are misclassified at these gestational ages.

The TYT curve was compared to Lubchenco and Alisjahbana curves. The comparison of mean birth weight for each curve is presented (Fig. 2).

Generally, the TYT study curve had lower average weights for each gestational age compared to the Lubchenco curve except for 34–37 weeks. Compared to the Alisjahbana curve, the TYT curve also generally had lower average weights except for 37–39 weeks. The curve model estimation showed that the appropriate model was the quadratic regression model.

For the Lubchenco curve, the formula to estimate birth weight is -21043.733 + 1134.926 x GA - 13.208 x GA2 ($R2= 0.992$, $p<0.001$) while for Alisjahbana curve the formula is -4661.533 + 317.166 x GA - 3.067 x GA2 ($R2= 0.968$, $p>0.05$). TYT study curve formula to estimate birth weight is -24852.567 + 1365.165 x GA - 16.635 x GA2 ($R2= 0.996$, $p<0.001$).

After all data were plotted into the TYT study curve, a significant difference among the three curves was found (Fig. 3).

Discussion

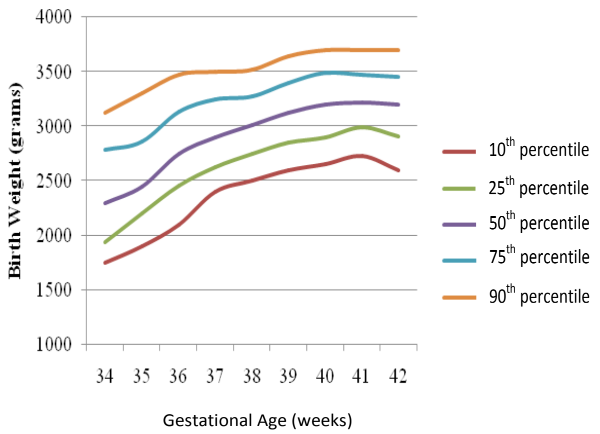
The differences of the ‘normal’ standard of reference birth weight per gestational age and sex between the TYT, Lubchenco, and Alisjahbana curves support the need for updated gestational age and gender-specific growth curves for certain population.

The three curves used quite a reasonable

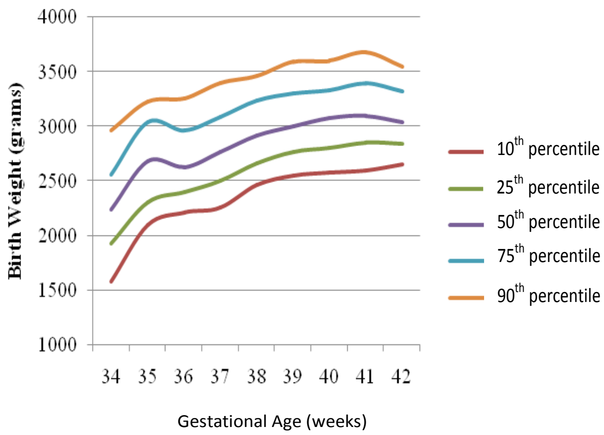
Table 3 Female Birth Weight Percentiles by Gestational Age

GA	n	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	Mean	SD
34	66	1,332	1,578	1,926	2,243	2,563	2,243	510.7
35	96	1,799	2,099	2,309	2,683	3,040	2,654	461.9
36	132	2,100	2,215	2,400	2,630	2,963	2,685	389.8
37	311	2,084	2,254	2,500	2,765	3,090	2,803	438.9
38	574	2,359	2,463	2,664	2,915	3,236	2,951	386.6
39	814	2,425	2,550	2,770	3,000	3,300	3,036	390.1
40	736	2,450	2,575	2,800	3,075	3,335	3,084	389.5
41	338	2,405	2,598	2,850	3,100	3,393	3,109	395.5
42	141	2,500	2,657	2,838	3,040	3,318	3,083	358.2

A. Male



B. Female



C. Combined

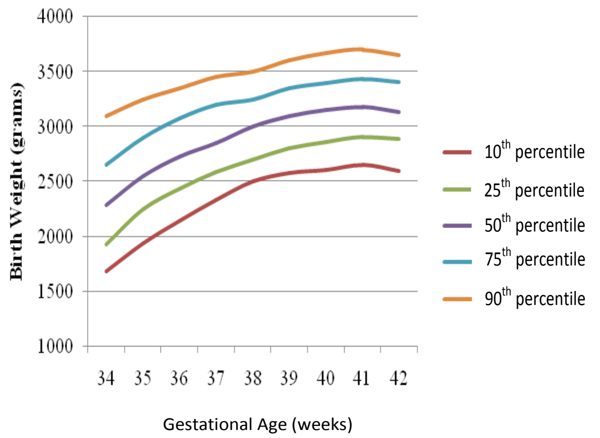


Fig. 1 TYT Study Curve (Gender Specific and Combined). TYT Study Curve for: (A) Male Infants, (B) Female Infants, (C) Both Sex

sample size of more than 5,000 births in each study. The Lubchenco curve offers advantages over the Alisjahbana curve due to a reasonable small grid increments (i.e., weekly for GA; every 200 g of weight; percentiles (versus SDs from mean)) for easier interpretation. The Alisjahbana curve offers superiority in terms of data sources that was retrieved from 14 hospitals in Indonesia.

There are similar drawbacks found in the three studies. First, there are possible errors in the gestational age calculation. To get more accurate gestational age, ultrasonography can be perfomed during the first trimester. Second, the limited population at Dr. Hasan Sadikin General Hospital due to the fact that most patients came from West Java makes this curve may not be appropriate for the whole Indonesian population.

Prospective, multicenter research is needed to represent all Indonesian populations, especially from centers where ultrasonography is available. The use of the TYT curve value to determine intrauterine growth should be assessed in larger population.

It is concluded from this study that the new gender-specific intrauterine growth curves created will provide clinicians with an updated tool for the assessment of newborn intrauterine

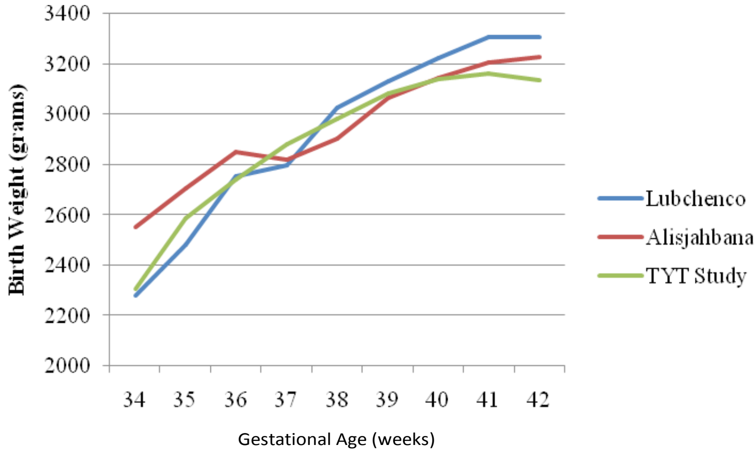


Fig. 2 Comparison of Mean Birth Weight for Each Gestational Age from Lubchenco, Alisjahbana, and TYT Study Curve

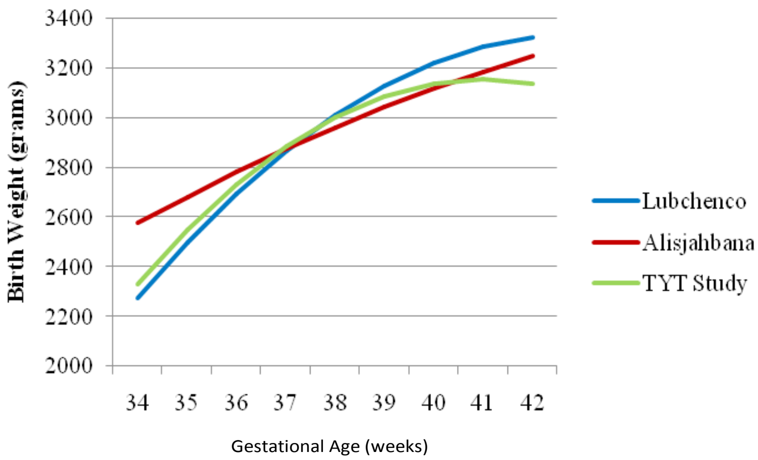


Fig. 3 Comparison of Quadratic Regression Curve of Mean Birth Weight from Lubchenco, Alisjahbana, and TYT Study Curve

growth status in West Java.

We strongly suggest nation-wide research using ultrasonography to assess gestational age more accurately starting in the first trimester.

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