

## DEVELOPMENT OF MULTIVARIATE QUALITY CONTROL AND QUALITY ASSURANCE MODELS FOR ANTENATAL CARE SERVICE IN INDONESIA

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Neonatal mortality rate (NMR) is an increasingly important public health issue in many developing countries. With an estimated 154 preterm births per 1000 live births in 2010, Indonesia was ranked fifth highest for preterm births in the world. Estimated birth weight is a significant indicator of the optimal growth, survival and future well-being of newborns. Low birth weight (LBW) is well documented as one of the factors that contributes most to neonatal mortality and it can be caused by preterm birth.

Access to routine data on estimated foetal weight (EFW) at a given gestation age (GA) is required to develop a foetal growth chart. Lack of access to such data is one of the reasons for the absence of a standard foetal growth chart in Indonesian antenatal care (ANC) practices. Consistent monitoring of EFW using a foetal growth chart allows early detection of growth abnormalities and can initiate interventions to ensure safe delivery. Low performance of ANC services in measuring and documenting the key performance indicators (KPIs) for maternal and foetal risk assessment is one of the major barriers to reducing NMR in Indonesia.

This research has developed statistical quality assurance systems to assess the efficacy of the current performance of ANC services in reducing NMR, particularly among Indonesian rural primary health care centres. This includes identification of the most significant KPIs during pregnancy. To optimise the practical applicability of the research outcomes, a data measuring and recording model that provides a more reliable medical database for the national health system was developed. This was followed by initiating scientific and technical training among urban and rural midwives to improve

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the quality of routine ANC data collection tasks for maternal and foetal risk assessment and development of a foetal growth chart.

The training has equipped 19 urban and rural midwives in South Kalimantan province with the scientific knowledge and technical abilities to carry out routine collection of ANC data. The ANC information on 4946 women (retrospective cohort study) and 381 women (prospective cohort study) has been used to assess the impact of the scientific and technical training, particularly its impact on the ability of midwives in settings with limited resources to collect and record the KPIs for maternal and foetal risk assessment and the data for developing the proposed foetal growth chart.

The results show that the training has significantly improved the average amount of recorded data for maternal and foetal risk assessment (with improvement from 17.5 to 62.1%,  $p$ -value < 0.0005) and for developing the foetal growth chart (from 33.4 to 89.1%,  $p$ -value < 0.0005). Midwives' views regarding factors which affect their ability to successfully complete the data documentation tasks have also been explored. Lack of awareness, high workload and insufficient skills and facilities are the main reasons for gaps in the data.

This research has developed reliable regression models that can easily be implemented in rural primary health care centres to accurately predict EFW at a given GA in the absence of ultrasound facilities. Multiple comparison criteria showed that the proposed models are more accurate than the existing clinical and ultrasound models in predicting foetal weight between 35 and 41 weeks of GA, and much more accurate at earlier GAs. The results also indicate that foetal weight can be best predicted by the measurement of maternal fundal height (FH). The model based on FH can be utilised in rural areas where advanced health equipment such as ultrasound is not always accessible.

Prior to the development of a new foetal growth chart, the research reviewed the existing growth charts for EFW. The potential challenges in utilising such surveillance tools in Indonesia were also investigated. The results showed that the customised and standard foetal growth charts for EFW used internationally had been developed and highly recommended for use without local data being available. Moreover, limited access to ultrasound measurement of foetal biometric characteristics hindered foetal weight estimation using the existing models. Low levels of recording of the minimum database requirements on individual maternal, foetal and neonatal characteristics also made the existing customised charts less applicable in the local setting.

For the first time an alternative foetal growth chart for EFW, which requires information only on FH, has been developed to monitor and identify unusual growth of a foetus. The efficacy of the proposed chart has been assessed by using it to look for abnormal patterns of foetal growth in the data recorded for normal and LBW newborns. The results highlighted the effectiveness of the developed growth chart for risk assessment during pregnancy to prevent the occurrence of LBW delivery. Using prospective data, it was shown that the proposed chart can effectively detect signs of abnormality between 20 and 41 weeks of GA. It was also shown that the existing foetal growth chart does not fit Indonesian data in the absence of ultrasound information.

This research has also evaluated the prediction accuracy of the ultrasound-based prediction models used in the development of the existing foetal growth charts for EFW and compared them with the proposed clinical-based prediction model using the Indonesian data. The results showed that the proposed model has comparable ability and is even more effective at earlier GAs in predicting foetal weight than the existing models. This justifies the utilisation of the proposed prediction model in the development of the new foetal growth chart.

The outcome of this research provides a useful administrative and scientific guideline for the expansion of health services programs and for the more effective distribution of limited government resources in rural areas. It includes analysis of where further aid investments are likely to best impact on reducing the NMR. The outcome also aids midwives in identifying the key risk factors and types of clinical interventions required prior to delivery to reduce the mortality rate.

Some of the research in the thesis has been published in [1–6].

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