



SYNOPSIS

DATA DRIVEN PUBLIC POLICY: AN ACTUARIAL JOURNEY IN MATERNAL HEALTH

Jananie William

Maternal health, Health system costs, Public health, Public policy, Adverse birth outcomes, Classification and regression trees, Generalized linear models, Generalized linear mixed effects models, Administrative data, Australian Longitudinal Survey for Women's Health, Data linkage, External data.

Purpose of your paper: We use an actuarial approach to identify the risk factors of Australian maternal health costs, with a focus on women who experience adverse birth outcomes. We demonstrate the benefits of using actuarial techniques on a large linked dataset and highlight how the results can be used to inform public policy.

Synopsis: We use an actuarial approach to identify the risk factors of maternal health system costs in Australia, with a focus on women who experience adverse birth outcomes. There is a paucity of research in this area but the few international studies that report on maternal health costs found that they were significant and needed to be addressed. To date, however, no such studies have been conducted with Australian data. For the purpose of this study we define adverse birth outcomes as: premature birth, low birth weight, congenital conditions, stillbirth and neonatal deaths.

The aims of this research are threefold: to quantify the difference between maternal health system costs of women who experience adverse birth outcomes and those that do not ("cost differentials"), to identify risk factors that drive the maternal health system costs ("cost risk factors") and to use the results to inform maternal health policy. The analysis is split into two separate but related costing studies - hospital and out-of-hospital costing. The costs are considered from the perspective of the government to inform public policy so is specifically focused on how much the government spends in these two areas. In order to focus the hospital costing study on government costs only, the data is split by public and private patient status for comparison purposes. For the out-of-hospital study, Medicare benefits are assessed with an indicator for private health insurance status so differences between private and public patients are also analysed in this study. Considering maternal health costs from the perspective of government specifically excludes all other costs (for example, out-of-pocket costs incurred by individuals, private health insurance costs and all infant costs). The costing studies are also split into three sub-periods of the perinatal period as the drivers of cost are likely to be different for each sub-period. The sub-periods are the antenatal period (the pregnancy period), delivery period (which includes labour and delivery) and the postnatal period (covers one year following the date of delivery).

The data used for both studies is drawn from the Australian Longitudinal Study on Women's Health (ALSWH) and numerous administrative data linked with the survey data. The ALSWH is a national longitudinal survey of over 40,000 women in three age cohorts and provides a richness of information in women's physical and mental health; psychosocial aspects of health (socio-demographic and lifestyle factors); and use of health services. These data also provide excellent coverage of the perinatal period and give important insights into the woman's life. In addition numerous administrative data including Medicare Data for the out-of-hospital study; the NSW Admitted Patient's Data Collection (APDC), the NSW Perinatal Data Collection, Congenital Conditions Registry, Perinatal Death Review, ABS Register of Births, Deaths and Marriages and ABS Mortality Data (Deaths only) for the hospital study is linked with ALSWH to provide information regarding costs and adverse birth outcomes. The data was prepared for linkage by the Center for Health Record Linkage (CHeReL) and an extensive data linkage exercise is undertaken so that the data is fit for the purpose



of actuarial modelling. The final dataset consists of 2520 and 1875 women for the out-of-hospital and hospital study respectively.

We propose a two-phase modelling methodology that adopts actuarial methods from typical insurance claim cost modelling and extends into other statistical techniques to account for the large volume of covariates available for modelling. Specifically, Classification and Regression Trees (CART), Generalised Linear Model (GLMs) and Generalised Linear Mixed Models (GLMMs) are employed on the large linked dataset. Maternal health costs are modelled by considering inflationary effects over time; large and small costs; and frequency (service utilisation) and severity (average cost of service). These techniques have not been applied in previous research in this area and they contribute by providing a more in-depth understanding of the underlying drivers of maternal health costs. In particular, by including a large number of covariates (from both survey and administrative data) within a multivariate statistical analysis, each cost risk factor is considered in the presence of numerous other factors (including adverse births) in order to identify which cost risk factors are the most significant given the impacts of all other factors. This feature, in turn, will identify the most important areas on which to focus policy recommendations to improve the outcomes for these women in a cost-effective manner. The potential covariates are grouped into the six broad categories of demographics, health service use, health behaviours, psychological and physical health, obstetric and reproductive factors and over 200 factors are tested for significance in the models to ensure a complete picture of the maternal health costs is formed.

The results for both costing studies show that the mean maternal health system cost differentials (for adverse births) are substantial; with mean cost differentials of 23% and 27% for hospital and out-of-hospital costs, respectively. Notwithstanding the fundamental differences between our study and previous international studies both in terms of scope and methodology, these amounts are broadly in line with the existing international literature. Adverse births are also a statistically significant cost risk factor (even in the presence of other cost risk factors) in a few key areas: hospital delivery periods for public cases and out-of-hospital delivery and postnatal periods for both public and private cases. The findings of this study show that adverse births are only statistically significant from a cost perspective around the time of the occurrence of the adverse event (that is, during the delivery period and following into the postnatal period). The predicted cost differentials are also lower than the simple mean cost differentials as other cost risk factors also explain the variation in cost. This highlights the importance of considering the cost in a multivariate context as this approach enables a much more nuanced understanding of the actual impact of each risk factor on cost. Conversely, this finding also shows that adverse births are not a significant cost risk factor for a number of different segments (and time periods) too. It is not significant in the antenatal models for both private and public cases in both hospital and out-of-hospital models. In summary, the key cost risk factors vary substantially across hospital costs and out-of-hospital costs, patient status (private or public) and perinatal sub-period. The delivery period is the most notable for hospital costs as over 80% of the costs are incurred in this period. The key risk factors in this period are mode of delivery, private health insurance status, labour onset, diabetes, area of residence, adverse births and smoking status. For out-of-hospital costs, both the antenatal and postnatal periods are important and the key cost risk factors are IVF, specialist use, GP use, private health insurance status, area of residence, adverse births and mental health factors (including anxiety, intense anxiety, postnatal depression and stress about own health). Mental health factors dominated the out-of-hospital study with many of these factors significant in both the antenatal and postnatal period.

The findings of this research provide evidence of a number of key areas where health resources may be directed and each significant cost risk factor warrants further research. For example, the statistical significance of private health insurance status in both the hospital and out-of-hospital study suggests that the government's policies on private health insurance which encourage certain demographics to purchase insurance will impact quite significantly on maternal health costs so the complexity and interactions of the mixed public-private system is an area that is worth exploring further. Additionally,



mental health policy is identified as a priority area for further consideration given the dominance of these factors in many models. Numerous mental health initiatives are recommended based on collaboration with public health experts from ALSWH (Catherine Chojenta and Deborah Loxton) and findings from other studies that consider mental health disorders in the perinatal period. These initiatives include a national universal mental health screening protocol for antenatal and postnatal periods in conjunction with improved screening methods and health services that focus on holistic, proactive early intervention so that mental health problems are detected and treated early. While these recommendations are likely to require increased funding in some areas, the results of this study suggest they are worth exploring further as investing in preventative strategies are likely to reduce costs in the future and improve health outcomes when these women experience major life events such as the birth of a baby.

Finally, this study is the first time actuarial techniques have been applied to maternal health costs, and thus this work is an important example of how actuarial skills are transferrable from traditional areas of actuarial work to non-traditional areas. Many key principles from general insurance have been utilised in this study, namely: the use of exposure as a measure of risk; the use of numerous risk factors to explain cost drivers; inflationary considerations of cost over different time periods; segmentation of costs into different sub-periods; segmentation of costs into small and large; and separate analysis of frequency and severity of costs. This study shows that these types of actuarial techniques which have been used in insurance for decades are successfully transferrable to other disciplines – such knowledge translation offers insights that have previously been unavailable in research on maternal health costs. In addition to this important contribution of actuarial work, the use of the results to inform policy using a substantive evidence base with a focus on risks and collaboration with public health experts is an example of how actuaries can take advantage of their multidisciplinary skill-set in a public policy setting. In summary, this research brings together elements of numerous disciplines and applies a holistic approach to provide important insights into maternal health policy.