

Estimated burden of premature death and morbidity from low birth weight infants in Thailand

ABSTRACT

Aims: The aim of this study was to estimate the burden of premature death and morbidity consequences due to infants born with low birth weight (LBW).

Study design: This study was a secondary data analysis and part of the burden of diseases and injuries study in Thai population in 2014.

Methodology: Data were collected from national public health statistics, vital registration database and, the morbidity burden from LBW consequences was analyzed according to the Global Burden of Disease (GBD 2000) study. The burden was estimated by disability adjusted life years (DALYs). DALYs are the combination of two components: years of life lost (YLL) and years lived with disability (YLD).

Results: Among registered livebirths in 2014, 10.4% were born with birth weight less than or equal to 2500g accounting for 180,853 healthy lives lost. Death due to LBW was 2.4 per 1000 livebirths for both sexes and LBW was the leading cause of death in under 5-year-old children. Cerebral palsy and mild permanent disabilities were the highest attributed morbidity burden among children with disability. Estimated burden of LBW attributed 16.1% of total DALYs loss from all-causes burden among under 5-year-old.

Conclusion: LBW remains a burden in Thailand. Premature death was the primary driver to total DALYs lost. The current study revealed the need to develop appropriate interventions for developmental delay and children with disability, and to conduct a long term follow-up study concerning infants born with LBW.

Keywords: Low birth weight, premature death, Years of life lost, Year lived with disability, Disability-adjusted life year, Thailand.

1. INTRODUCTION

Newborn weight is one of the indicators of maternal health and nutrition status [1, 2, 3] and is important for infants' survival, growth and health risk [4, 5, 6]. LBW has been defined by the World Health Organization (WHO) as weight at birth less than 2500 grams (g) or about 5.5 pounds [7]. Infants born with LBW are at higher risk of dying especially in their first year than infants with normal birth weight [8]. While trying to achieve one of the targets of Sustainable Development Goal (SDGs) [9] by reducing child mortality, significant reduction in LBW prevalence is an important contribution.

Moreover, many related studies have documented that LBW affects the infant's physical growth and intellectual development process. Although children with LBW were reported to be free from severe handicaps during early childhood, other problems were observed including neurological development and growth sequelae still persisting until young adulthood [10, 11]. Children born with LBW also risk developing a lower IQ and cognitive disabilities, negatively affecting their performance at school and their job opportunities as adults [10, 12, 13]. Additionally, LBW infants who survive may also have increased risk of diseases in later life [14, 15].

Globally, more than 20 million babies are born with low birth weight (LBW) each year, approximately 16% of all livebirths. More than 95% of all LBW babies are born in developing countries [7]. A large variation exists in the prevalence of LBW across regions especially low and middle income countries.

Asia has the highest LBW rate in the world at 18.3% and is especially highest in south-central Asia at 27% [16].

The incidence of infants born with LBW remains a public health problem in many countries including Thailand [8, 17, 18, 19]. In the 1980s, the proportion of LBW in total livebirths was about 12% in Thailand, and declined throughout 1990-2000 (about 8-9%) with little annual variation [20]. The Multiple Indicator Cluster Survey (MICS 2015-2016) reported that 9.4% of most recent livebirths within the last two years weighed below 2,500 grams at birth [21].

According to the Global Burden of Diseases Study 2004, LBW contributed to more than 44.3 million healthy lives lost globally [22]. As the developmental delays worsen in early childhood period and continue throughout life, the society, community, caregivers and parents should be equipped to accommodate disabled children's needs. [11]. Moreover, significant health and developmental impacts due to LBW can impose huge costs on society [23, 24]. Estimating the burden of LBW by disability adjusted life years (DALYs) is important for not only to implement appropriate developmental and educational programs by identifying disability consequences, but also to consider intervention prioritization and evaluation on the efficacy of the interventions to reduce the overall burden.

The objective of this study was to estimate the burden of LBW in Thailand in 2014 by combining the premature death and long term consequences.

2. METHODOLOGY

2.1 Study design

This study was a secondary data analysis, part of the burden of disease and injury estimation concerning the Thai population in 2014. Burden due to infants born with LBW was estimated by means of DALYs, a health gap measured by combining years of life lost (YLL) due to premature death and years lived with disability (YLD) due to specific nonfatal conditions. One DALY means one lost year of "healthy" life.

2.2 Data sources and Disease consequences

The information of the infant's weight at birth was collected from "Thailand Public Health Statistics 2014" report [25], as this is the most reliable and available data at the national level. The national civil registration system (vital registration system) was used to estimate the mortality burden. The coverage for underreported infant deaths was adjusted with the Infant Mortality Rate (IMR) from the "Population Change Survey (SPC) 2005-2006".

In this study, LBW was classified into (1) very low birth weight (VLBW, ≤ 1500 g), and (2) LBW (1501-2500g). Survivors among LBW infants was estimated based on VLBW or birth weight 1501-2500g according to the literature review [8, 17, 18, 19], with 80% and 98.3%, respectively. Among survived infants, 25% of VLBW, and 5% of LBW (1501-2500g) had disability consequences, defined by Shibuya and Murray study [26], and five major disability conditions are considered according to the Global Burden of Disease Study (GBD 2000) [27].

The proportion of disability consequences among total disabled infants was obtained from Shibuya and Murray (1996) study [26] for epilepsy (4.2%), hearing loss (2.8%), and vision loss (4.8%). Mental retardation (intellectual disability) due to LBW was estimated from the overall estimates of mental retardation from the Burden of Disease and Injury Study Thailand 2014, with the distribution of mild (62%), moderate (22%), severe (11%) and profound (5%) levels. In addition, 60% of total incident of cerebral palsy (CP) cases (at 2.25 per 1000 livebirths) was attributed to LBW similar to an Australian study [28]. Rather than these five major consequences, the rest of the disable proportion of LBW infants was categorized as other mild permanent disabilities attributed by LBW. Standard reviews of local data sources were referred to and discussed with external experts to derive the best estimate of disabling sequelae due to LBW.

2.3 Data Analysis

Total DALYs were analyzed based on the GBD 2000 Study [27] by combining the two components below.

$$\text{DALYs} = \text{YLL} + \text{YLD}$$

A detailed description can be found in Murray and Lopez (1996) [29]. YLL is calculated using

$$\text{YLL} = \sum dx \cdot ex$$

where ex is the expected life at age x based on standard life expectancy and derived from the Coale and Demeny West Model 26 life table; dx represents the number of deaths at age x (number of deaths by LBW). YLD is calculated using

$$\text{YLD} = I \cdot DW \cdot L$$

where I is the number of incident cases in the reference period, DW represents the disability weight and L is the average length of disability until remission or death measured in years.

Disability weight (DW) indicates the valuation of a health state, scale from zero (perfect health) to one (worst possible). DW for all causes and consequences are referred from Dutch Weight [30]. Burden estimation of mental disorders was used as a reference for the duration of disability from differing levels of mental retardation due to LBW. Durations for the other sequelae were assumed to be less than normal life expectancy at birth and were projected using the Dismod Program [31] with twice the background mortality rate [32] without remission.

3. RESULTS AND DISCUSSION

3.1 Distribution of LBW among livebirths

In Thailand, 711,805 livebirths registered in 2014. Among them, 74,345 newborns (10.4% of total livebirths) were born with birth weight less than or equal 2500g with 9.6% among male and 11.4% among female livebirths. Among all LBW infants, there were 0.8% with birth weight ≤ 1500 g and 9.7% with birth weight 1501-2500g (Table 1). According to the statistics record, higher proportion of LBW among Livebirths were observed in mothers aged group ≤ 15 years (20.3%), 45-49 years (18.5%) and ≥ 50 years (22.2%) compared with other aged groups. Among all LBW infants, 21.7% were born from adolescent mothers (aged < 20 years).

Table 1. Distribution of infants with LBW by category among males and females

	Male		Female		Both	
	Number	% in total LBs	Number	% in total LBs	Number	% in total LBs
Total livebirths (LBs)	366649	100.0	345156	100.0	711805	100.0
VLBW ≤ 1500 g	2924	0.8	2765	0.8	5689	0.8
LBW 1501-2500g	32165	8.8	36491	10.6	68656	9.7
Total LBWs	35089	9.6	39256	11.4	74345	10.4

VLBW: very low birth weight, LBW: low birth weight.

3.2 Healthy life loss from premature death due to LBW

Death due to LBW attributed more than 40% among all-cause of deaths from perinatal conditions (International Classification of Diseases (ICD-10 code) P00-P96) [33] under 1 year, with more than half among males and one third among females. Mortality rate due to LBW was 2.4 per 1000 livebirths in total, with 3.4 among males (1264 deaths) and 1.4 among females (473 deaths) in this analysis.

YLLs due to premature death are presented in Table 2. In total 140,055 years lost from premature death with higher distribution among males (72.2%) than females (27.8%).

Table 2. Premature death due to LBW, its proportion in all-cause of deaths from perinatal condition, and year life lost by sex.

	Number of deaths		Mortality rate per 1000 livebirths		% of LBW in all-cause of perinatal conditions	YLL
	LBW	All-cause of perinatal conditions *	LBW	All-cause of perinatal conditions		
Male	1264	2460	3.4	6.7	51.4	101059
Female	473	1509	1.4	4.4	31.3	38996
Total	1737	3969	2.4	5.8	43.8	140055

*Number of deaths from all-cause of perinatal conditions (ICD-10 code P00-P96) were referred from Burden of Diseases and Injuries Study in Thailand 2014 [34] . YLL: Year life lost.

3.3 Healthy life lost due to morbidity consequences from LBW

The number of infants for all disability outcomes due to LBW was 4,513 in total (2,166 among males and 2,347 among females). Overall YLD due to LBW was 40,799 years. Nearly one half of the morbidity burden was attributed to mild permanent disabilities (48.5%) followed by cerebral palsy without intellectual disability (25.9%). Severe hearing loss, moderate vision loss and mild intellectual disability contributed nearly 6% of total YLD, individually. Only 5% of total YLD contributed to moderate, severe and profound intellectual disability (mental retardation) due to LBW. A higher morbidity burden was found among females than among males; thus, a relatively high incidence of LBW infants was observed in the female group. Estimated numbers of infants with disability and YLD counts for all disability sequelae of LBW as presented in Table 3.

Table 3. Total number of newborns with disability and YLD counts due to LBW by sex

Sequelae	DW	Duration (years)		Total number of cases		YLD		Total YLDs of both (% in grand total)
		M	F	M	F	M	F	
Intellectual disability								
Mild	0.290	61.9	68.0	69	54	1,231	1,062	2296 (5.6)
Moderate	0.430	49.9	54.8	24	19	514	444	958 (2.4)
Severe	0.820	43.9	48.2	12	9	432	372	804 (2.0)
Profound	0.760	30.7	33.7	5	4	123	106	229 (0.6)
Cerebral palsy (without intellectual disability)	0.170	59.9	69.0	453	508	4,611	5,955	10566 (25.9)
Epilepsy	0.110	59.9	69.0	91	99	599	748	1347 (3.3)
Severe hearing loss (congenital or early acquired)	0.230	59.9	69.0	78	84	1,074	1,340	2414 (5.9)
Moderate vision loss	0.170	59.9	69.0	104	113	1,058	1,320	2378 (5.8)
Others Mild permanent disability	0.110	59.9	69.0	1,330	1,457	8,760	11,049	19809 (48.5)
Grand Total				2,166	2,347	18,403	22,396	40799 (100)

DW: Disability weight, M: Male, F: Female, YLD: Year lived with disability.

3.4 Distribution of DALYs lost by LBW in total DALYs of under 5-year-old children

Total DALYs due to infants born with LBW was 180,853 years accounting for 66.1% among males and 33.9% among females. YLLs due to LBW contributed 77.4% of total DALYs and the rest 22.6% was attributed by YLDs. Higher DALYs attribution by LBW among under 5-year DALYs lost was found in male (19.4%) than in females (12.1%). Nearly 20% of total YLL and 10.5% of total YLD among infants under 5 year-old contributed to LBW burden (Table 4).

Table 4. YLD, YLL, DALYs account for LBW and its contribution in under 5-year-old total burden.

	Total Burden of all-causes in <5year-olds* in years			Burden of LBW in years (% of burden from LBW in total burden of all-causes among <5year-olds)		
	YLL	YLD	DALYs	YLL	YLD	DALYs
Male	409247	207811	617058	101059 (24.7)	18403 (8.9)	119462 (19.4)
Female	327481	180858	508339	38996 (11.9)	22396 (12.4)	61391 (12.1)
Total	736728	388669	1125397	140055 (19.0)	40799 (10.5)	180853 (16.1)

* Total burden of YLL, YLD and DALYs of under 5-year-old children were referred from Burden of Diseases and Injuries Study in Thailand 2014 [34].

YLL: Year life lost, YLD: Year lived with disability, DALYs: Disability adjusted life years

In 2014, 10.4% of LBW accounted for 180,853 years of DALYs lost. Total DALYs lost due to LBW in male was nearly twice compared with that of in female. From the study analysis, DALYs lost due to LBW contributed to about 16.1% of total in under 5-year-old children and 11.1% in under 15-year-olds for males and females in 2014 [34]. Compared with 1999 [35], LBW burden in 2014 became second-ranked among females under 15-year-old while the same ranking among under 15-year-old males. That decreased in burden ranking among females might be due to the increased survival rate of infants with LBW in females (46.2% of total deaths by LBW attributed by females in 1999 vs. only 27.2% in 2014).

From the aspect of mortality burden, premature death was primarily driven to overall DALYs lost due to LBW. More than 40% of total deaths from all perinatal conditions (under ICD-10 code P00-P96) can be attributed to LBW. According to the burden of diseases and injuries study in Thailand 2014, infant mortality rate from all perinatal conditions (under ICD-10 code P00-P96) was 5.8 per 1000 livebirths and it was higher than national public health statistics report (2014) where infant mortality rate was 3.3 per 1000 livebirths [25]. The study of Lumbiganon et al. mentioned that Thai perinatal and infant mortality rates obtained from officially reported was lower compared with other sources due to failure to register as many people do not recognize the importance of valid health statistics, and so fail to report infant deaths when the birth has not yet been registered [36]. Different mortality rate from LBW by gender was observed in this study and it was more likely among males than female. Similarly, Stevenson et al. reported that boys were more likely to die than girls of those born with low birth weight [37]. The mortality rate from LBW by geographical area did not examine separately in this analysis, but the southern region of Thailand had the highest overall infant mortality rate than other regions according to the national public health statistics [25] and highest proportion of infants born with LBW among livebirths in last two years according to MICS (2015-2016) report [21]. It was due to the lowest coverage of maternal and child health (MCH) in that region compared with other regions, although the overall coverage of MCH in national level was more than 95% [38].

Regarding the morbidity burden, non-fatal adverse health outcomes due to LBW concerning short term (during hospitalization) and long term were presented in many studies. But the current estimation followed the GBD 2000 study and the estimation did not include short term burden during hospitalization such as asphyxia, respiratory infections, necrotizing enterocolitis, intraventricular hemorrhage, moderate or severe bronchopulmonary dysplasia [17, 18, 19]. Additionally, Hintz et al study on neurodevelopmental outcomes reported observable differences between boys and girls, but not consistently in favor of girls [39]. Therefore, we considered the same proportion of the morbidity outcomes between males and females. Moreover, there has been different risk of morbidity and impaired growth depending on the categories of birth weight [40]. As the proportion of the VLBW was

less than 1% in the total livebirths, the burden of consequences was not analyzed separately on birth weight categories. But, regarding the original source of the proportion of disability consequences, Shibuya and Murray estimated the proportion of disabilities for all infants with LBW based on the relative proportion of total LBW cases for each birth weight category to obtain the total disable proportion [26].

The disability outcomes may vary with the study characteristics. According to our hypothesis, estimating disabilities such as hearing, vision loss, CP, epilepsy and intellectual disability comprised about 3%, 5%, 21.3%, 4.2% and 4.3% of total children with disabilities, respectively. But, one Thai cohort study on 18 to 24 months follow-up concerning growth and developmental outcomes among 30 infants with VLBW reported that 3.3% presented hearing abnormalities and 16.7% presented vision loss of all very low birth weight cases [19]. One reason of disability proportion difference between two studies was that this study was hospital based and focused only on VLBW outcomes while current study estimated disability from overall LBW cases. An evidence-based review study of Cole reported that the disabilities outcomes were varies depend on the birth weight with the proportion of disabilities are as follow: 7-17% of ELBW infants and 7-10% of VLBW infants had cerebral palsy, 12-50% had neurologic disability, 5-21% had blindness and 8-11% had deafness [40]. Another study, predicted disability, resulting from preterm births in Bangladesh indicated that 35.2% presented intellectual disabilities, 3.4% exhibited hearing loss and 7.9% presented vision defects [41]. Depend on the variation in study designs, sample characteristics: preterm (gestational age) or/and LBW, LBW categories and outcome measurements criteria, analyzing and comparing results among studies is sometimes difficult.

Many related studies revealed that the risk and chance of adverse health outcomes are inversely related to not only birth weight but also gestational age at birth, and both of these factors are highly correlated with interdependent risk to health [40, 42]. Because of that reason, in recent years, many studies preferably use gestational age as the major marker to measure the prematurity to predict adverse health outcomes [10, 13, 40, 42]. Although birth weight is not a perfect measure as it might be disproportionately large or small for the gestational age, the current study used birth weight because almost all, 98.9%, of infants are weighed at birth [21] and can avoid discrepancies when assessing gestational age [12]. The Global Burden of Disease Report 2010 estimated that DALYs due to preterm birth (short gestational age) in East-Southeast Asia and the Pacific contributed to about 10% of the worldwide total burden [43].

Improving maternal nutritional status, preventing risk factors during pregnancy and reducing adolescent pregnancies would be great benefit on reducing the infants born with LBW and preterm baby. Higher rate of LBW among infants born from mothers aged <15 years and over 45 year-old than other aged groups suggests considering quality and coverage of antenatal care services including early assessment of at-risk and high risk pregnancies to all targeted groups [44] while trying to achieve the third target of "six global nutrition targets for 2025" comprising a 30% reduction of LBW prevalence by 2025 according to the World Health Assembly [16] and to reduce the child mortality. Moreover, building a good network of communication between medical personnel and LBW infants is crucial to early detection and interventions, and provide appropriate care and better follow-up to reduce negative health impact in childhood and later in adulthood [11, 19]. Special education and school programming interventions are required for the children with low IQ and impaired functions [11].

Some limitations occurred in the current study's estimation such as uncertainty regarding the vital registration for cause of death data, information gap of population-based cohort study concerning neurodevelopmental consequences, and underestimated burden as the current results did not covered short term burden during hospitalization and did not consider the determinant of short gestational age on adverse health outcomes.

Even though the study had certain limitations, it may be helpful in establishing research and clinical service priorities and, may be useful in providing information support on policy approaches to help children with developmental delays and disabilities.

4. CONCLUSION

LBW is the leading cause of burden among males and second rank among females under 5-year-old children. Premature death is the key driver of total DALYs due to LBW, and cerebral palsy (without intellectual disability) and mild permanent disabilities contribute the most to the morbidity burden. From this study, clinical and researchers are urged to address the healthcare needs for long term morbidity from LBW and gestational age as well. Moreover, this study encouraged the researchers to explore further investigations to identify consequent burden of LBW according to preterm birth and/or intrauterine growth restriction, and to obtain more precise results for policy makers to consider. Early detection, screening and adequate curative healthcare alongside behavioral, social, and special educational interventions are needed to implement appropriately to reduce the burden. The information from this study would be helpful to develop and implement effective and appropriate maternal and child health policies and allocate resources in health systems.

ETHICAL CONSIDERATION

This study is not applicable to ethical approval as it was the secondary data analysis and literature review.

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