DIPONEGORO MEDICAL JOURNAL
(Jurnal Kedokteran Diponegoro)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
Volume 10, Number 5, September 2021

ASSOCIATION BETWEEN BIRTH WEIGHT AND QUALITY OF LIFE IN EARLY AND MIDDLE ADOLESCENCE

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ABSTRACT

Background: Children with low birth weight tend to have a higher risk of experiencing abnormal growth and developmental delays. While the risk of developing obesity in the later years is higher in children with high birth weight. Physical and psychological conditions can affect the quality of life of adolescents. **Objective:** To analyze the association between birth weight and quality of life in early and middle adolescents. **Methods:** This cross-sectional study involved 120 students aged 13-16 years in Semarang City in which a consecutive sampling method was used. The study was conducted in August 2020. Research subjects need to fill up the PedsQL, PAQ, birth history, and socio-economic questionnaires. Statistical analyses used were Chi-square and logistic regression tests. **Results:** Birth weight was significantly associated with quality of life (p=0.002). A history of abnormal birth weight increases the risk of experiencing poor quality of life as a teenager (p=0.002; OR=3.987). Low birth weight was associated with decreased physical function (p=0.001), whereas high birth weight was associated with reduced social and school functioning (p=0.013; 0.032). Gender was significantly associated with quality of life (p=0.016). Girls tend to have a higher risk of experiencing poor quality of life (p=0.021; OR=4.021). **Conclusion:** Birth weight has a significant association with quality of life in early and middle adolescents. Adolescents with a history of LBW or HBW were more likely to experience decreased quality of life than adolescents with a history of NBW.

Keywords: *Adolescence, Birth weight, Quality of Life*

INTRODUCTION

Quality of life is one indicator of a nation's child welfare. Quality of life in children is based on children's health and daily activities (physical function), feelings and the way they express them (emotional function), ability to socialize in their environment (social function), and their ability to focus and carry out activities at school (school function).[1] These aspects of the quality of life will change when children enter adolescence.

Adolescence is a time when puberty occurs. Puberty refers to a series of changes that occur in the body, both physical and psychosocial, which mark the transition from children to adolescents. World Health Organization (WHO) divides adolescents into early, middle and late periods, which are respectively the 10-13, 14-17, and 18-19-year age groups. Hormonal changes in early and middle adolescents certainly affect the quality of life.[2] Increased sex hormones in early and middle adolescents can also affect cognitive abilities through epigenetic mechanisms, dendritic remodeling, myelination, and apoptosis in the brain.[3]

Quality of life can also be affected by birth weight. Newborn babies can be classified as low birth weight (LBW) babies if the birth weight is less than 2500 grams, normal birth weight (NBW) if 2500-4000 grams, and high birth weight (HBW) if the birth weight is more than 4000 grams.[4]

In 2018 there were 23.060 incidents of LBW from 535.630 births in Central Java.[5] In Indonesia, 6.2% of babies are born with LBW. This figure shows an increase from previous years. *Riset Kesehatan Dasar (Riskesdas)* in 2018 also reported that 3.7% of babies born in Indonesia were overweight.[6] Birth weight will affect the nutritional status of children as adolescents. Children with LBW have a high risk of death, short stature, and decreased brain development in childhood. Meanwhile, the risk of obesity in adolescence and adulthood will increase two times higher in babies born more than 3.9 kg.[7] Adolescents with overweight conditions are at risk of obesity, which is associated with various health problems and difficulties in carrying out daily activities. Underweight (body mass index (BMI) below normal) can cause a decrease in physical abilities,

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thinking abilities, and immune system, which can affect the quality of life in adolescents.[8]

Studies about the association between LBW, NBM, and HBW with the quality of life in early and middle adolescents is still limited in Indonesia. Previous studies only discussed the association between LBW and quality of life. We aim to analyze the association between birth weight and quality of life in early and middle adolescents. We also analyzed the impact of LBW and HBW on adolescent quality of life.

METHOD

An analytic observational study with a cross-sectional design was done in IBL clinical laboratory, Semarang, in August 2020. Subjects were children who fulfilled the inclusion criteria. The inclusion criteria were; students aged 13 to 16 years with no congenital anomalies, whose parents were willing to participate in the study and have given informed consent. Children with chronic disease and no history of birth weight were excluded. The minimum amount of sample was calculated through the following formula for unpaired comparative analytical study:[9]

$$n = \left(\frac{Z\alpha\sqrt{2PQ} + Z\beta\sqrt{(P_1Q_1 + P_2Q_2)}}{P_1 - P_2} \right)^2$$

The minimum number of samples based on this formula was 94.7 subjects and then rounded up to 120 subjects. The subjects were chosen by consecutive sampling based on inclusion and exclusion criteria until the required sample size was achieved.

We collected the following data; quality of life, history of birth weight, gender, physical activity, socioeconomic, and nutritional status from 120 subjects. In this study, the Pediatric Quality of Life Inventory (PedsQL) 4.0 Generic Core Scale was used to assess health-related quality of life. Subjects were asked to fill the PedsQL questionnaire after receiving directions and explanations. The PedsQL consists of 23 items, eight items on physical function, five items on emotional function, five items on social function, and five items on school function. A five-point response scale was used from 0 (never a problem) to 4 (almost always a problem), then converted to 0-100 scale (0=100, 1=75, 2=50, 3=25, 4=0). Quality of life is good if the total PedsQL score is ≥70 and is considered poor if the total PedsQL score is <70. Meanwhile, psychosocial function (emotional, social, and school function) is considered good if >80.[10]

Subjects also filled out the Physical Activity Questionnaire (PAQ) to determine the level of physical activity which is classified under five categories, namely, very low, low, moderate, high, and very high. The socioeconomic level was determined by the socio-economic questionnaire. To reduce bias, subjects were educated that there are no right or wrong answers in filling out the questionnaire.

The anthropometric values of each subject were measured to determine the nutritional status. Weight was measured to the nearest 0.1 kg using digital weight scales and height was measured to the nearest 0.1 cm using a microtoise 2M stature meter. BMI was calculated as weight (kg)/height (m^2). Indonesian Ministry of Health classifies the nutritional status by percentiles for age and gender into extremely underweight (<-3 SD), underweight (-3 SD to -2 SD), normal (-2 SD to 1 SD), overweight (>1 SD to 2 SD), and obese (>2 SD).

Subjects' demographic data (gender, birth date, age) and birth history (birth weight, gestational age, mother's age, and congenital anomalies) were collected from the birth history questionnaire. Any incomplete data will be followed up by interviewing the parents. Parents were asked to bring birth record book to reduce the risk of recall bias. COVID-19 protocol was implemented in the process of data collection.

A chi-square test was used to analyze the association between birth weight and quality of life. The logistic regression test was used to examine the association of birth weight and confounding variables with adolescent quality of life. Association was considered to be significant for P values <0.05 with 95% CI.

RESULTS

The characteristics of the study subjects are described in Table 1.

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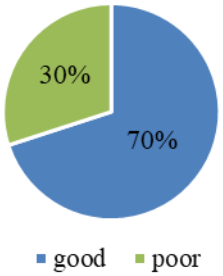
Table 1. Subjects' characteristics (N=120)

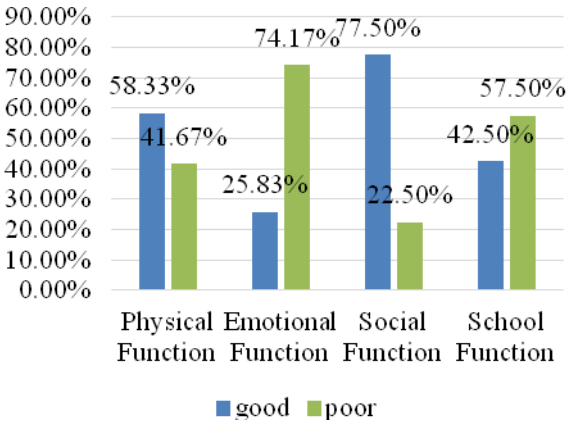
Characteristics	Mean ± SD (min-max)	n	%
Age (years)	14,98 ± 1,12 (13-16)	-	-
Weight (kg)	49,71 ± 11,66 (30-108,5)	-	-
Height (cm)	156,26 ± 7,39 (136-174)	-	-
Gender			
Male	-	31	25,8
Female	-	89	74,2
Birth Weight			
Low	-	23	19,2
Normal	-	82	68,3
High	-	15	12,5
Nutritional Status			
Extremely	-	4	3,3
underweight	-	9	7,5
Underweight	-	83	69,2
Normal	-	17	14,2
Overweight	-	7	5,8
Obese			
Physical Activity			
Very low	-	16	13,3
Low	-	85	70,8
Moderate	-	18	15,0
High	-	1	0,8
Very high	-	0	0,0
Socioeconomic			
Poor	-	5	4,2
Non-poor	-	115	95,8

The subjects of this study were dominated by female adolescents (74,2%), history of normal birth weight (68,3%), normal nutritional status (69,2%), low physical activity (70,8%), and high socioeconomic groups (95,8%).

Fig. 1 (a) shows the distribution of the total quality of life in subjects, and Fig. 1 (b) shows the assessment results of the four domains of quality of life. Most of the subjects showed good physical and social function. For emotional and school function, most of the subjects showed poor results. It can be seen that the subjects had various quality of life.



(a)



(b)

Figure 1. (a) Distribution of the total quality of life in subjects, (b) assessment results from four domains of quality of life.

Gender was significantly associated with quality of life (P <0.05). Meanwhile, nutritional status, physical activity, and socioeconomic were not significantly associated with quality of life (P>0.05).

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Table 2. Association between confounding factors and quality of life

Variables	Quality of life				*p*
	Good n=84		Poor n=36		
	n	%	n	%	
Gender					
Male	27	22,5	4	3,3	0,016 [a]*
Female	57	47,5	32	26,7	
Nutritional Status					
Extremely	3	2,5	1	0,8	
underweight	6	5,0	3	2,5	
Underweight	57	47,5	26	21,7	1,000[b]
Normal	14	11,7	3	2,5	
Overweight	4	3,3	3	2,5	
Obese					
Physical Activity					
Very low	14	1,7	2	1,7	
Low	54	45	31	25,8	0,915[b]
Moderate	15	12,5	3	2,5	
High	1	0,8	0	0	
Very high	0	0	0	0	
Socioeconomic					
Poor	3	2,5	2	1,7	0,474[c]
Not poor	81	67,5	34	28,3	

[a]Chi-Square test
[b]Kolmogorov-Smirnov test
[c]Fisher's-Exact test
Notes: Significant if p<0.05; *Significant

Table 3 shows the association between birth weight and quality of life. Based on table 3, the results of the chi-square test showed that the significance value (p) for the total quality of life, the domains of quality of life, physical function, emotional function, social function, and school function were: 0.002; 0.001; 0.117; 0.011; 0.018; respectively. Birth weight was significantly associated with quality of life. The individual domains of physical, social, and school functions were also significantly associated with birth weight. Meanwhile, the emotional function was not significantly associated with quality of life (*P*>0.05).

Table 4 shows the association between LBW and HBW with the general quality of life and the quality of life domain. LBW had a statistically significant association with the total quality of life and physical function (P= 0.012, P= 0.001, respectively). While, HBW had a statistically significant association with total quality of life, social, and school function (P= 0.013, P=0.013, P= 0.032, respectively).

Table 3. Association between birth weight and quality of life

	Birth weight		*p*[a]
	Normal n=82	Abnormal n=38	
Quality of life			
- Good	65 (54,2%)	19 (15,8%)	0,002*
- Poor	17 (14,2%)	19 (15,8%)	
Physical function			
- Good	56 (46,7%)	14 (11,7%)	0,001*
- Poor	26 (21,7%)	24 (20,0%)	
Emotional function			
- Good	25 (20,8%)	6 (5,0%)	0,117
- Poor	57 (47,5%)	32 (26,7%)	
Social function			
- Good	69 (57,5%)	24 (20,0%)	0,011*
- Poor	13 (10,8%)	14 (11,7%)	
School function			
- Good	41 (34,2%)	10 (8,3%)	0,018*
- Poor	41 (34,2%)	28 (23,3%)	

[a]Chi-Square test
Notes: Significant if p<0.05; *Significant

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Table 4. Association between LBW and HBW with the general quality of life and the quality of life domain.

	Birth weight					
	Normal n=82	**Low n=23**	***p***	**Normal n=82**	**High n=15**	***p***
Quality of life						
- Good	65 (54,2%)	12 (11,4%)	0,012 [a]*	65 (54,2%)	7 (7,2%)	0,013[a]*
- Poor	17 (14,2%)	11 (10,5%)		17 (14,2%)	8 (8,2%)	
Physical function						
- Good	56 (57,7%)	7 (6,7%)	0,001 [a]*	56 (57,7%)	7 (7,2%)	0,107 [a]
- Poor	26 (26,8%)	16 (15,2%)		26 (26,8%)	8 (8,2%)	
Emotional function	25 (25,8%)	4 (3,8%)	0,214 [a]	25 (25,8%)	2 (2,1 %)	0,146 [b]
- Good	57 (58,8%)	19 (18,1%)		57 (58,8%)	13 (13,4%)	
- Poor						
Social function						
- Good	69 (71,1%)	16 (15,2%)	0,104 [b]	69 (71,1%)	8 (8,2%)	0,013[b]*
- Poor	13 (13,4%)	7 (6,7%)		13 (13,4%)	7 (7,2%)	
School function						
- Good	41 (42,3%)	7 (6,7%)	0,096 [a]	41 (42,3%)	3 (6,8%)	0,032[a]*
- Poor	41 (42,3%)	16 (15,2%)		41 (42,3%)	12 (22,6%)	

[a]Chi-Square test
[b]Fisher's Exact test
Notes: Significant if p<0.05; *Significant

The results of the logistic regression analysis for birth weight and gender are shown in Table 5. We performed a multivariate analysis on the variables, which in the bivariate analysis had a p-value <0.25.

Table 5. Logistic regression analysis for birth weight and gender

Variables	Coeff	*p*	OR (95% CI)
Birth weight	1,383	0,002	3,987 (1,686-9,428)
Gender	1,392	0,021	4,021 (1,237-13,068)
Constant	-2,466	0,000	0,085

The results of the logistic regression analysis showed that the significance value (p) for birth weight and gender were: 0.002; 0.021, respectively. So, partially birth weight and gender affect the quality of life of early and middle adolescents. Adolescents with a history of abnormal birth weight (low or high) had a 3.987 times greater chance of experiencing poor quality of life than adolescents with a history of NBW. Girls were also 4.021 times more likely to experience a poor quality of life than boys.

Adolescents with a history of LBW had a mean quality of life score of 69.16 ± 15.73, while those with a history of HBW were 68.43 ± 16.74. This score was lower than the quality of life score for adolescents with a history of NBW (78.18 ± 11.71). Based on these results, adolescents with a history of abnormal birth weight (low or high) had decreased quality of life compared to children with a history of NBW.

The results of the logistic regression analysis for LBW and HBW are shown in table 6. The results of the logistic regression analysis showed that the significance value (p) for LBW and HBW were: 0.012, 0.012, respectively. So that partially LBW and HBW affect the quality of life of adolescents. Adolescents with a history of LBW were 3.505 times more likely to experience poor quality of life than adolescents with a history of NBW. Adolescents with a history of birth weight over 4,370 times more likely to experience a poor quality of life than adolescents with a history of NBW.

Table 6. Logistic regression analysis for low and high birth weight

Variable	Coeff	*p*	OR (95% CI)
Birth weight		0,006	
LBW	1,254	0,012	3,505 (1,319-9,310)
HBW	1,475	0,012	4,370 (1,389-13,750)
Constant	-1,341	0,000	0,262

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DISCUSSION

The results show that the prevalence of poor quality of life among adolescents in Semarang city was 30%. Adolescents have various levels of quality of life. Based on the results, there was a significant association between birth weight and quality of life in early and middle adolescents.

Adolescents with a history of LBW were 3.505 times more likely to experience a poor quality of life than adolescents with a history of NBW (Table 6). A history of low birth weight had a significant relationship with physical function. This finding is consistent with previous studies conducted by Baumann, which concluded that the quality of life of individuals with a history of LBW is lower than individuals with a history of NBW.[10] A history of LBW can make adolescents susceptible to health problems and decreased physical abilities.[8] In adolescents with a history of LBW, there is a change in white matter associated with cognitive decline and mental health. This change can cause problems related to decreased learning abilities, behavior, emotional, and low Intelligence Quotient (IQ) during adolescence.[11]

Adolescents with a history of HBW were 4,370 times more likely to experience a poor quality of life than adolescents with a history of NBW (Table 6). Obese pregnant women are at risk of giving birth to babies with HBW because of changes in the intrauterine environment that can affect the hormonal and nutritional balance of the fetus. Overnutrition during the prenatal period has a permanent impact on fetal physiology and metabolism, which can lead accumulation of fat in the fetus. These metabolic changes are found to persist into adulthood and increase the risk of long-term obesity.[12] However, there is still no clear mechanism regarding the direct effect of birth weight on hormone production in children. The association between HBW and the risk of obesity can also affect psychosocial aspects that lead to low self-confidence so that adolescents become stressed and find it difficult to get along with peers.[13] Stress can also interfere with health, causing disruption of school functioning and affecting academic achievement.

A previous study stated that the quality of life of adolescents with normal nutritional status was higher than adolescents with abnormal nutritional status.[14] However, our study did not show a significant association between nutritional status and quality of life in adolescence. This study is in line with the research of Sakti RP, et al., which stated that there were no significant association between obesity and adolescent quality of life.[15] Another study also stated that there were no significant differences regarding the psychosocial QoL between the different nutritional status categories.[16] This difference may be explained by the human ability to adapt and use denial as a defense mechanism when answering questionnaires.[17]

In adipose tissue, cortisone (an inactive corticoid) is converted to cortisol (active corticoid) by the enzyme 11-Beta-hydroxysteroid dehydrogenase-1 (11HSD1), so that cortisol levels are increased in obese adolescents.[18] Long-term obesity also increases Tumor Necrosis Factor-alpha (TNF-α) and proinflammatory cytokines that cause damage to Leydig cells that lead to decreased testosterone production and decreased production of neurotransmitters that play a role in cognitive abilities such as acetylcholine and dopamine.[19]

In adolescents with low nutritional status, the brain's metabolic processes are low due to insufficient nutrition for brain development. Adolescents with low nutritional status also have the risk of anemia due to inadequate nutrition.[20] One of the effects of anemia is a decrease in learning ability due to low concentration. Psychosocial (stigma, teasing, and bullying) and comorbid problems can also cause adolescents to miss school and cause their learning abilities to be left behind.

Based on the results of this study, the domain of quality of life that did not have a significant association with a history of birth weight was emotional function. Early and middle age adolescents are experiencing a phase of identity crisis and tend to be emotional.[21,22] So that poor emotional function dominates the study subjects, and adolescents with a history of NBW, LBW, or HBW show the same results.

Based on the frequency of incidence of poor quality of life in adolescents, young girls had lower physical, emotional, and school functions than boys. Girls were 4.021 times more likely to experience a poor quality of life than boys (Table 5). This is consistent with previous studies, which showed that boys have a higher quality of life than girls.[23,24] Girls are more sensitive to changes that occur in themselves, which triggers stress and increases the

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E-ISSN : 2540-8844
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cortisol hormone in the body. High estrogen levels in women can decrease the response of the hypothalamus-pituitary-adrenal axis, which causes a decrease in negative feedback on cortisol in the brain so that cortisol levels remain high.[25] If this happens continuously, cortisol can damage the function of T cells and causes decreased immunity.[26]

Physical activity can increase the level of β-endorphins in the blood. Endorphins are neuropeptides produced by the brain. Endorphins can replace stress hormones, so the emotions become more stable.[27] Unlike previous studies, our study showed that physical activity did not have a significant association with quality of life. This can be caused by the lack of diversity in the characteristics of the subjects in this study. Subjects were dominated by groups with low levels of physical activity, while the subjects with high physical activity were only 0.8%. Low physical activity did not significantly affect the cardiorespiratory fitness of the subject.[28]

Most immune cells in the human body have receptors for endorphins and need endorphins to function properly.[29] β - endorphins play a role in the immune response by synthesizing antibodies, lymphocyte proliferation, increasing levels of anti-inflammatory cytokines, and activating natural killer (NK) cells.[30,31] Regular physical activity can also stimulate the production of neurotransmitters and increase learning abilities by improving the circulation system in the brain. The brain also works optimally because the needs of oxygen, nutrients, and energy for the brain are fulfilled.[32] Physical activity also increases leptin sensitivity and reprograms the long-term metabolic effects of prenatal problems such as macrosomia.[33]

Previous studies of socioeconomic and quality of life showed that quality of life is also associated with socio-economic conditions. In contrast, our study found that the socio-economic group did not have a significant relationship with the quality of life. This is probably because the respondents are mainly from the higher socio-economic group. Only 4.17% of the subjects are categorized under the low socio-economic group, so the result of the socio-economic association test with quality of life is not significant.

There were some limitations to our study. The history of birth weight data obtained from interviews with the parents resulted in the risk of recall bias. We also did not assess the association between stress and a history of birth weight and quality of life in adolescents. The COVID-19 pandemic situation also affects the psychological aspects of adolescents, which can cause adolescents to have trouble sleeping, find it difficult to focus, easily forget, and decreased their quality of life. Additional study is needed for further analysis of the link between stress and quality of life in adolescents. Future studies should be multicenter studies with a larger sample and a wider scope to increase the accuracy of the study results. In clinical practice, birth weight can be used to predict the quality of life of a child in the future.

CONCLUSION

Birth weight had a significant association with quality of life in early and middle adolescence. Adolescents with a history of LBW or HBW were more likely to experience decreased quality of life than adolescents with a history of NBW.

Ethical Approval

All procedures have been approved by the issuance of ethical clearance No. 142/EC/KEPK/FK-UNDIP/VI/2020 from the Health Research Ethics Commission of the Faculty of Medicine, Diponegoro University, Semarang.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

The authors received no specific grants from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions

Conceptualization, ELN; methodology, ELN; validation, DTA, ANRS, and TWN; formal analysis, ELN; investigation, ELN; resources, ELN; data curation, ELN; writing—original draft preparation, ELN; writing—review and editing, ELN, DTA, ANRS, and TWN; supervision, DTA, ANRS, and TKN; project administration, ELN.

Acknowledgments

This study was presented in a thesis seminar as partial fulfillment of the requirements for attaining the bachelor's degree of Medicine in Diponegoro University Medical School. We would like to acknowledge the subjects, their parents, and those who had assisted in this study.

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DIPONEGORO MEDICAL JOURNAL
(Jurnal Kedokteran Diponegoro)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
Volume 10, Number 5, September 2021

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