

Path Analysis on Life Course Factors Affecting Overweight and Obesity in Children Aged 2 to 5 Years Old in Surakarta

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ABSTRACT

Background: Globally, prevalence of obesity in children under 5 years old has been increasing from 32 million in 1990 to 42 million in 2014. Indonesia ranks highest in the number of obesity cases in South East Asia with prevalence of 11.5% in 2013. However, child overweight and obesity have not been the focus of health problems in Indonesia. Early intervention and prevention of child obesity can reduce long-term risk of chronic diseases in adulthood. This study aimed to analyze the life course factors affecting overweight and obesity in children aged 2 to 5 years old in Surakarta.

Subjects and Method: This was an analytic observational study with case control design. The study was conducted in 5 community health centers, Surakarta, from September to October, 2017. A total sample of 150 children aged 2 to 5 years old was selected using fixed disease sampling. The dependent variable was overweight or obesity. The independent variables were nutrition intake, exclusive breastfeeding, starting age of complementary feeding, physical activity, birthweight, age of gestation, sectio cesarea labor, maternal body mass index, and maternal job. Physical activity data was measured using Pre PAQ questionnaire. Other data were collected using a set of questionnaire and maternal and child health monitoring book. The data were analyzed by path analysis.

Results: Overweight and obesity in children aged 2 to 5 years old were positively affected by over nutrition intake (b= 1.9; 95% CI= 0.15 to 3.60; p=0.033), high maternal body mass index (b= 2.0; 95% CI= 0.51 to 3.42; p=0.008), and sectio cesarean birth (b= 2.1; 95% CI= 0.56 to 3.73; p=0.008). Overweight and obesity in children aged 2 to 5 years old were negatively affected by normal birthweight (b= -2.2; 95% CI= -4.28 to -0.19; p=0.032), exclusive breastfeeding (b= -2.0; 95% CI= -3.60 to -0.39; p=0.015), timely starting age of complementary feeding (b= -1.3; 95% CI= -2.80 to 0.11; p=0.072), and high physical activity (b= -3.0; 95% CI= -4.63 to -1.37; p=0.001). Birthweight was positively affected by age of gestation (b= 4.2; 95% CI= 1.99 to 6.32; p=0.001) and was negatively affected by maternal body mass index (b= -1.1; 95% CI= -2.11 to -0.13; p=0.025). Exclusive breastfeeding was negatively affected by working outside the house (b= -1.4; 95% CI= -2.10 to -0.72; p= 0.001).

Conclusion: Overweight and obesity in children aged 2 to 5 years old are positively affected by over nutrition intake, high maternal body mass index, and sectio cesarean birth. Overweight and obesity in children aged 2 to 5 years old are negatively affected by normal birthweight, exclusive breastfeeding, timely starting age of complementary feeding, and high physical activity.

Keyword: life course factors, overweight, obesity, path analysis.

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BACKGROUND

Nutritional problems in ASIA become double burden in which on one side, wasting and stunting is still high, on the other hand obesity is also increasing

(UNICEF, WHO and World Bank, 2014; Black et al., 2013). Currently, all countries in the world are facing problems of epidemiological transition of diseases which are not infectious in both developed

and developing countries. Risk factors that increase the potential for non-infectious diseases include overweight and obesity (WHO, 2016). As described in NCDs, overweight and obesity cause 55% of deaths from non-infectious diseases (WHO, 2016b).

Overweight and children under 5 obesity have increased globally from 32 million in 1990 to 41 million by 2014 (WHO, 2016b). All over the world, overweight and obesity in infants and children are predicted to increase to 70 million by 2025. With the increase in the proportion of obesity cases at different ages, it has become one of the nine targets of the global monitoring program framework for non-infectious diseases (WHO, 2014; Wijnhoven et al., 2016).

The number of overweight and children obesity cases in Asia continues to increase. In 2013, the highest number of overweight and children obesity in Azerbaijan was 13.0% and the lowest one was at Vannatu (4.6%). In Southeast Asia, the highest overweight and children obesity is in Indonesia which was 11.5% and the lowest one was in the Philippines for about 5.0% (ADB, 2016).

Obesity and its association with various comorbidities have posed a serious threat to the global health (Han, et al., 2017). Obesity is a major cause of cardiovascular disease (Hardy, 2015). Overweight and obesity are the main risks of serious chronic diseases (Labresh, 2016). Overweight and obesity in children increase the risk of death 40-90% higher in their adulthood than normal children do (Hirko et al., 2015).

Overweight and obesity in childhood lead to morbidity and mortality in adulthood (Redsell et al., 2016). Obesity that continues into adulthood can lead to chronic diseases, such as hypertension, type

2 diabetes, heart disease, certain types of cancer development, insomnia and sleep disorders (Ahima, 2014; Debasis, 2011; Godfrey et al., 2017; Ramírez et al., 2016). Obesity can cause negative impacts on children's mental and social health, low self-esteem and depression (Small and Aplasca, 2016). Therefore, efforts to prevent overweight and obesity need to be done early (Blake-Lamb et al., 2016). Factors that affect obesity include, genetic history, obese parents, smoking, low and over birth weight, not receiving exclusive breastfeeding and rapid duration, the quality of child's sleep, unbalanced diet which is high in calories and fat, less physical activity, and at a higher level it may be affected by circumstances in communities, environments, and demographic factors (Bammann et al., 2014; Poston, 2012). The influence of other factors such as genetic, biological, socio-cultural, psychological and environmental factors is a risk factor for obesity (Herman et al., 2014; Isgor et al., 2016).

Early detection of overweight and obesity cases is a way of preventing and reducing risk factors that will occur in the future (Redsell et al., 2016; Weng et al., 2012). Health programs that focus on addressing these nutritional problems are the first thousand days of life nutrition to ensure that children grow well as they progress. Good growth and development in the first 1000 days of life will determine the future child development (Blake-Lamb et al., 2016; Woo Baidal et al., 2016).

Overweight and obesity status are also associated with lifelong epidemiology from gestation to adult children (Bammann et al., 2014). A growing theory explains that the lifelong exposure relationship to adult disease is a life course epidemiology (Green and Popham, 2017; Pérez-escamilla and Kac, 2013).

Based on Indonesia's 2015 health profile, the classification of energy levels and characteristics is found that the largest overweight and obesity rate in Indonesia is between the ages of 5-12 and 10.2%, of it occurs in various regions both urban and rural. The incidence rate in urban areas is 6.9% and in rural area is 5.8% (Ministry of Health, 2015). Obesity in Central Java in 2016 was 1.867 (3.1%) and was included in five major non-infectious diseases (Central Java Provincial Health Office, 2016). The prevalence of overweight and obesity in the age group of 2-5 years was 5.4% overweight and 1.7% for obesity. One area with an increased prevalence of overweight and obese children aged 2-5 years was Surakarta district, in 2014, for about 3.7% increase from the previous year which was only 1.45% (Surakarta Health Office, 2014).

Although in Surakarta it has not become a major problem but overweight and obesity in children 2-5 years need to get more attention considering the increase of health problems caused by it. A preliminary study conducted at the Surakarta health office shows that 1530 infants were overweight and obese. The purpose of this study is to know the influence of path analysis of factors throughout life on overweight and obesity of children under five in Surakarta.

SUBJECTS AND METHOD

1. Study design

This was an analytic observational study with a case control design, by determining the group which was exposed first and then identifying the cause or risk factors of the disease. The study was conducted at Ngoresan, Gilingan, Stabelan, Nusukan, and Penumping community health centers, Surakarta, Central Java, from September 2 to November 28, 2016.

2. Population and sample

The target population was Toddlers aged 2-5 years who live in Surakarta. The source population were underweight (2-5 years old) toddlers living in the area of Ngoresan, Gilingan, Stabelan, Nusukan and Penumping Public Health Centers which were overweight and obese and normal (under-five) toddlers for about 150 subjects with the comparison of 1: 2. The case group consisted of 50 subjects and the control one consisted of 100 subjects.

The sampling technique used in this study was fixed disease sampling by choosing the subjects based on the data of overweight and obese children and normal children at the public health centers, then the data collection process was conducted at integrated health service. The selection of subjects was done randomly according to the sample size required by the researcher. There were ten variables in this study. The dependent variable is overweight and obesity toddlers. The independent variables were maternal body index, gestational age, cesarean delivery, birth weight, exclusive breastfeeding, breastfeeding feeding age, physical activity, diet, and maternal occupation.

3. Operational of variables

Overweight or obese in children under five was defined by calculated bodyweight/ body height and compared with Z-score. The measurement scale was continuous, but for the purpose of data analysis, it was transformed into dichotomous, coded 0 for normal weight and 1 for overweight/ obesity.

The history of the mother with overweight / obesity was determined based on maternal BMI during pregnancy and recorded in the maternal and child monitoring book. Gestational age was defined as the length of time that begins from the time of ovulation to the birth, the duration of distal birth (<37 weeks), and term delivery

(≥37 weeks). Sectio caesarean was defined as the expenditure of conception with an incision on the maternal abdomen.

Exclusive breastfeeding was defined as only breastmilk consumed by infants until the first 6 months of age. The age at complementary feeding was defined as the first age of children introduced with solid foods.

Physical activity was defined as the movement that generates the measured energy with the children which is intermittent and is interrupted by breaks and were measured by the Pre-PAQ questionnaire. The diet pattern includes the type, amount and frequency consumed each day. Maternal occupation was defined an act done to earn wages.

4. Study instrument

The data collection used questionnaires and KIA books. The instruments that were tested for reliability were dietary and physical activity questionnaires. Based on the results of the correlation reliability test item-total dietary variables were *r* count

≥0.22 and Cronbach Alpha ≥0.77, on the physical activity variables *r* arithmetic ≥0.21 and Cronbach Alpha ≥0.91, so that all questions/items were stated as reliable.

5. Data analysis

This study used path analysis. This analysis can calculate the magnitude of the direct and indirect effects of any independent variable on the dependent variable. Steps to perform path analysis included model specifications, model identification, model conformity, parameter estimation, and model respecification.

6. Research ethics

The research ethical clearance was obtained from the Research Ethics Committee at Dr. Moewardi Hospital, Surakarta, Central Java, Indonesia. Research ethics included issues such as informed consent, anonymity, confidentiality, and ethical clearance.

RESULTS

1. Sample Characteristics

The characteristics of subjects in this study are presented in Table 1.

Table 1. The Distribution of study subjects

Characteristics	Obesity (case)		Normoweight (control)	
	n	%	n	%
Gender				
Male	26	52	53	53
Female	24	48	47	47
Maternal age (year)				
<35	29	58	72	72
≥35	21	42	28	28
Children age (months)				
<36	19	38	43	43
≥36	31	62	57	57
Number of children				
<3	42	84	74	74
≥3	8	16	26	26
Maternal education				
Low (<Senior high schol)	10	20	36	36
High (≥Senior high school)	40	80	64	64
Family Income				
< Rp 2,000,000	18	36	53	53
≥ Rp 2,000,000	32	64	47	47

Table 1 shows the characteristics of the study subjects from 150 of them, 26 were male (52%) and 53 control (53%). The number of ,others who were <35 years old was 29 (58%) cases and 72 (72%) for the control one. There were 31 (62%) under-five children who were over 36 months. As many as 40 (80%) mothers had education ≥Senior high school.

2. Path Analysis

Figure 1 shows the structural model after estimating data processing using STATA 13

application with SEM (Structural Equation Modeling) program. Path analysis explains the direct and indirect effects of overweight and obesity causes in infants. The degree of freedom (df) = 35 value is over-identified so that path analysis can be done. This study has been in accordance with the sample data shown by the saturation model and also the regression coefficient which is more than zero and statistically significant, so there is no need to re-create the path analysis model.

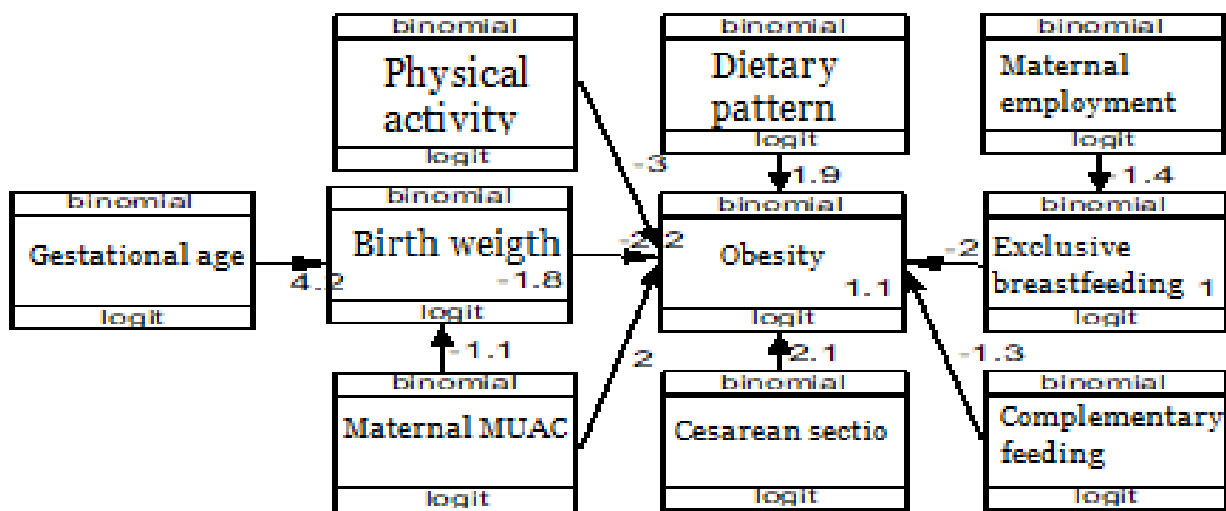


Figure 1. Structural model of path analysis

Table 2 shows that there is an association of Maternal BMI with an overweight increase and obese infant which was statistically significant. Overweight/ obese mothers had overweight and overweight children's obesity scores of 2 units higher than normal body mass index mothers (b = 2.0; 95% CI = 0.51 to 3.42; p = 0.008).

There was a relationship between birth weight and the decrease of overweight or obesity in children which was statistically significant. Normal birth weight has overweight logit score and obesity of underweight of 2.2 units lower than underweight children with low birth weight

(<2,500 g) (b = -2.2; 95% CI = -4.28 to -0.19; p = 0.032).

There was a relationship between a cesarean delivery and the increase of overweight and obesity in children and was statistically significant. Cesarean delivery had overweight and overweight children's obesity scores of 2.1 units higher than mothers with normal delivery (b = 2.1; 95% CI = 0.56 to 3.73; p = 0.008).

There was a relationship between exclusive breastfeeding and a decrease of overweight and obesity in children under five and was statically significant. Exclusive breastfeeding had an overweight logit score and under-five obesity of 2 units

lower than toddlers who do not get exclusive breastfeeding (b = -2.0; 95% CI = -3.60 to -0.39; p = 0.015).

There a correlation between age at complementary feeding and the decrease of overweight and obesity in under-five children and was statistically significant. Age at complementary feeding more than 6 months had overweight logit score and childhood obesity of 1.3 units lower than under-five children given breastfeeding MP less than 6 months (b = -1.3; 95% CI = -2.80 to 0.11; p = 0.072).

There was a relationship between physical activity and the decrease of overweight and obesity in under-five children and was stated as statistically significant. Active physical activity had

overweight logit score and underweight obesity of 3 units lower than under-five children with inactive physical activity (b = -3.0; 95% CI = -4.63 to -1.37; p = 0.001).

There was a significant relationship between diet with overweight and underweight obesity. A diet high in carbohydrates and fats had overweight and overweight children's obesity scores of 2 units higher than low-carbohydrate and fat diets (b = 1.9; 95% CI = 0.15 to 3.60; p = 0.033).

There was a statistically significant relationship between gestational age and birth weight gain. Gestational age (<37 weeks) had a low birth weight logit score of 4.2 units higher than gestational age (≥37 weeks) (b = 4.2; 95% CI = 1.99 to 6.32; p = 0.001).

Table 2. Results of pathway analysis of lifetime overweight and obese factors in children

Dependent Variable	Independent Variable	Path Coefficient	95% CI		p
			Lower Limit	Upper Limit	
Direct Effect					
Overweight/ Obesity	← Mothers body mass index	2.0	0.51	3.42	0.008
	← Birth weight	-2.2	-4.28	-0.19	0.032
	← Caesarean section	2.1	0.56	3.73	0.008
	← Exclusive breastfeeding	-2.0	-3.60	-0.39	0.015
	← The first age at complementary feeding	-1.3	-2.80	0.11	0.072
	← Physical activity	-3.0	-4.63	-1.37	0.001
	← Dietary pattern	1.9	0.15	3.60	0.033
Indirect Effect					
Birth weight	← Gestational age	4.2	1.99	6.32	0.001
	← Mothers body mass index	-1.1	-2.11	-0.13	0.025
Asi Eksklusif	← Occupation	-1.4	-2.10	-0.72	0.001
Log Likelihood= -175.82					

There was a statistically significant relationship between maternal body mass index and weight loss. Mothers with normal body mass index had a lower birth weight logit score of 1.1 units lower than that of overweight mothers / obese (b = -1.1; 95% CI = -2.11 to -0.13; p = 0.025).

There was a statistically significant correlation between maternal employment status and the decrease of exclusive breastfeeding. The working mother had a logit score of 1.4 units lower than that of the housewife (b = -1.4; 95% CI = -2.10 to -0.72; p = 0.001).

DISCUSSION

1. The effect of maternal body mass index (BMI) with overweight or obesity in children under five

The result of this study showed that there was a positive and significant effect between maternal body mass index and overweight and obesity in children. Mothers with overweight/obesity were more likely to have overweight/obesity infants compared to mothers with normal weight.

Obesity in pregnant women is associated with excessive amounts of nutrients to the fetus in the form of fatty acids, increased fetal blood pressure and the accumulation of babies' body fat. The enhancement of body weight and body fat will increase the risk of obesity to children in the future. Pregnant women with obesity lead to trans-generational thus increasing the risk of disease in their babies (Koletzko *et al.*, 2014).

The overweight during pregnancy will continue until postpartum. The evidence-based cycle of heredity suggests that newborns from overweight/obese pregnancies are more likely to store excessive body fat from the earliest period in life (Pérez-escamilla and Kac, 2013).

The history of obese parents increased the risk of overweight in children by 1.38 times compared to parents with normal body weight (Mamun, *et al.*, 2014).

The study of Bammann *et al.* (2014) found that parental body weight before high pregnancy was associated with obesity in children by 1.02 times than mothers with normal body weight. Children with obese parents have 10.25 times risk to be obese and 3.03 times to have metabolic syndrome compared with parents without obesity (Han *et al.*, 2015).

2. The effect of birthweight with overweight or obesity in children under five

The result of this study showed that there was a negative and significant effect between birthweight with overweight and obesity in toddlers. Babies with normal birthweight decrease the risk of overweight/ obesity in toddlers compared to babies with low birthweight.

Low birth weight was associated with increased coronary heart disease, stroke, hypertension, obesity, insulin resistance and type 2 diabetes. The association is considered to be a consequence from the development of different genotypical plasticity in both physiological and environmental morphologies during the development (Barker, 2004; Robinson *et al.*, 2015).

Low birthweight infants have higher plasma levels than normal-weight infants. The enhancement of leptin and the fat mass ratio are also associated with nutrient intake during childhood resulting in the enhancement of leptin production by body fat units. In low birth-weight children, the leptin levels increase with the growth rate in childhood, therefore, the children will have a higher risk of overweight and obesity (Jornayvaz *et al.*, 2016).

A study conducted by Yang and Huffman (2013) shows that birth weight less than 2,500 g has a risk of metabolic syndrome and has central obesity in adulthood, compared to normal birthweight. Other studies explain that children with low birth weight and low physical activity showed 5.18 times more likely to become obese (Qiao *et al.*, 2017).

3. The effect of sectio cesarean birth with overweight or obesity in children under five

The result showed that section cesarean birth has positive effect on overweight/ obesity in toddlers which is statistically

significant. Cesarean section increased the risk of overweight/obesity in toddlers. The intestinal flora of children born from cesarean birth has low levels of bifidobacteria. In children who born from cesarean section, there is lack of good bacteria from mothers found in birth canal, while the enhancement of bad bacteria can harm the child's immune system, this affects the child's susceptibility to overweight and obesity (Sutharsan *et al.*, 2015). The exposure of gut microbiota in children with cesarean delivery section can increase the potential of biological mechanisms of obesity in the development of infants and children (Kuhle, *et al.*, 2015).

The results of a study on pre-school children aged 3-6 years old, 67.3% have a history of sectio cesarean birth and 15.7% are obese. Cesarean delivery increases overweight by 1.7 times and obesity by 1.29 times than normal-born children (Rutayisire *et al.*, 2016).

The study of Pluymen *et al.* (2016) suggests that 236 or 8.9% of children born from cesarean section had a 1.52 times higher risk of overweight and obesity than children with prevaginam delivery. Similar study also explained that 70% of children with sectio cesarean birth have 1.49 times higher risk of obesity than children with normal birth delivery (Flemming *et al.*, 2013).

4. The effect of exclusive breastfeeding with overweight or obesity in children under five

The result showed that exclusive breastfeeding has an effect on overweight/obesity in toddlers which is statistically significant.

Infants with formula milk as the food sources have a higher and longer insulin response than breast-fed children, therefore, it stimulates more fat tissue deposition and resulting in weight gain. Breast-fed children have the ability to regulate the

body's internal energy response in recognizing satiety rather than formula-fed children (Binns *et al.*, 2016; Martin *et al.*, 2017). the concentration of leptin (a hormone that works to inhibit appetite and regulate fat in the body) was found with a more balanced concentration in children who were breastfed rather than formula-fed (Daniels *et al.*, 2015).

Non-exclusive breastfeeding causes obesity of 29.9% higher than exclusive breastfeeding up to 2 years old. In addition, infants who are not breastfed have risk of type 2 diabetes mellitus (Ramírez *et al.*, 2016).

Giving exclusive breastfeeding for less than six months increases the risk of obesity than giving exclusive breastfeeding for more than six months (Daniels *et al.*, 2015; Woo Baidal *et al.*, 2016). Infants with formula milk before 4 months old will increase the risk of obesity in toddlers after 3 years old (Bammann *et al.*, 2014). Breastfeeding is a way of protecting children from obesity risk factors later in life, especially breastfeeding in the first year of life (Weng *et al.*, 2014).

5. The effect of first age at complementary feeding with overweight or obesity in children under five

The result of this study showed that the timely starting age of complementary feeding has an effect on overweight/obesity in toddlers which is statistically significant. Infants with first age of complementary food more than 6 months decrease the risk for overweight/obesity in toddlers.

Exclusive breastfeeding and timely introduction of complementary foods is a prevention of obesity in the future. Complementary foods and high protein intake from an early age was associated with the enhancement of fat mass and obesity in adulthood (Yang and Huffman, 2013).

Based on a study by Zheng et al. (2015), from 40,510 children, 3.18% have excess body weight and 64.8% were given complementary foods before 3 months old. Complementary feeding before the age of 3 months is associated to the risk enhancement by 11% for overweight or 1.11 times higher risk for overweight/obesity or increased z-score than complementary feeding at 6 months old.

Research with systematic review and meta-analysis showed an association between complementary feeding under 4 months old, including 4-6 months old increase the risk of overweight with a relative risk of 1.18 and obesity with a relative risk of 1.33 higher for the overweight and obese in toddlers compared to complementary feeding at 6 months old (Wang *et al.*, 2017).

6. The effect of physical activity with overweight or obesity in children under five

The result of this study showed that children with high physical activities decreased the risk of obesity (negative relationship). The result was statistically significant so that the findings are influential and reliable.

Physical activity is needed in burning the calories in the body. Excessive energy intake and not balanced by adequate physical activity will increase the risk for overweight (Colley *et al.*, 2013). The standard practice of recommended physical activity in toddlers is not too heavy but encourages the children to always actively move, as an intervention and reduce the risk of daily habits of children who are lazy to move, therefore, they will be easily to have overweight or obesity (Howie *et al.*, 2014).

A study by Laurson *et al.* (2014) explained about weight gain of children who follow the physical activity guidelines,

in which children who rarely follow physical activities are 3.1 times more likely in boys and 2.5 times in girls to have overweight and obese than children who regularly follow physical activity guidelines. Other study explained that physical activity in children for less than 1 hour increase overweight and obesity in children by 5.69 times greater than in children who perform physical activity more than 1 hour per day (Zamzani, *et al.*, 2016).

7. The effect of dietary pattern with overweight/obesity

The result of this study showed that a diet high in fats and carbohydrates increased energy intake which will further impact on obesity with positive relationships which is statistically significant so that these findings are reliable.

Obesity is caused by an imbalance between the amount of energy that enters and the needs of the body for various biological functions such as physical growth, development, activity, health maintenance. If this condition persists continuously (positive energy balance) in long-term period, then it can lead to obesity (Ahima, 2014; Burton-jeangros *et al.*, 2015; Laurson *et al.*, 2014).

Obesity in the early period of life is influenced by the promotion of dietary habit and healthy eating habits, sedentary and physical activity. Increased prevalence of adipocytes can be known in an early life, family and environmental parenting will increase the chances of children to become obese since early stage. The implementation of the dietary habit and healthy living in children is an early intervention for the occurrence of obesity (Campbell *et al.*, 2016).

Studies show that high-carbohydrate and fat dietary compounds have higher risk of obesity by 1.18 times than low-fat diets and carbohydrate consumption patterns,

balanced by lack of physical activity, and daily habits that can lead to obesity such as watching TV and playing games (Choukem *et al.*, 2017).

Family habits with wrong dietary habit such as, family modeling, lack of nutritional knowledge, eating time, giving food as a gift, affordability and constraints of good food access and environmental factors also affect children's dietary habit and increase food intake, such as on food availability, advertising, socio-cultural influences and babysitters. All these factors can be the cause of obesity in children associated with dietary habit (Paes, *et al.*, 2015).

8. The effect of maternal gestational age with overweight or obesity through birthweight

The result of this study showed that mothers with gestational age (<37 weeks) had an effect on overweight/obesity of children through birthweight. Mothers with less gestational age increase the risk of low birthweight, which furthermore becomes more risky for overweight / obesity in infants.

Pre-term gestational age (premature) is a very important perinatal and public health issue, not only because of high rates of neonatal morbidity and mortality and low birth weight, but also an impact on quality throughout the life of the population (Bronstein, 2016; Calkins, *et al.*, 2011).

Premature birth is associated with changes in nutritional status and and the need for normal weight return. Births with very low birthweight, metabolic enhancement, combined with dietary habit, perspectives on nutritional improvement, childhood eating habits, environmental and cultural social determinants, increase the risk in this population. A variety of factors increase the risk of nutritional status to become overweight and chronic illness to

the psychological risks caused by premature (Andrade *et al.*, 2015).

A study by McDonald *et al.* (2010) using systematic review and meta-analysis in developing countries shows that gestational age has an effect on low birthweight and overweight/obesity. Lower gestational age with low birth weight (<2,500 g) was found to be the highest in women with overweight and obesity, with a relative risk of 1.30 times higher than normal mothers. Overweight and maternal obesity also increases the risk for premature birth (37 weeks) due to medical indications with a relative risk of 1.24 times higher. The highest incidence rate in developing countries with a relative risk of 0.58 higher than developed countries.

9. The effect of maternal BMI with overweight/ obesity through birthweight

The result of this study showed that mothers with overweight/obesity increase the risk of low birthweight which continued to be more risky for overweight/obesity, and it is statistically significant.

Obese mothers significantly modified bolus gene expression associated with neutral lipid transport and storage. Increased regulation of CGI-58, regulator of TG hydrolysis system, contributes to intracellular lipid turnover in placenta of obese women, and it is strictly regulated by maternal metabolic factors (Hirschmugl *et al.*, 2017).

The function of the placenta can affect fetal adiposity tissue at the primary nutritional level. High plasma levels of certain nutrients of obese mothers are considered important as a nutrient transfer link to the fetus resulting in fat accretion that poses a higher risk of fetal weight or low birthweight, due to differences in the differential bolus transfer nutrition settings

required for fetal growth (Lewis *et al.*, 2013).

Mothers with obesity are associated with adverse long-term effects on children's health such as an increased risk of low birthweight, obesity, metabolic regulation leading to the enhancement of insulin resistance, hypertension, heart and asthma risk. The complex relationship between maternal and fetal metabolic as well as environmental influences and postpartum lifestyle increases the risk of overweight/obesity of children from pregnancy to birth (O'Reilly and Reynolds, 2013).

The results of the study in Sweden showed that the risk of preterm delivery increased at less gestational age of overweight and obese mothers, a mother with a body mass index (BMI) of 25 to less than 30 increases the risk by 1.26 times, BMI 30 to less than 35 increases the risk by 1.58 times, BMI 35 to less than 40 increases the risk by 2.1 times and BMI more than 40 increase the risk by 2.99 times. The enhancement of maternal BMI will increase the incidence of premature in toddlers. Spontaneous preterm birth occurs in mothers with BMI 30 and prematurely as a result of medical indications increase in mothers between overweight and obesity (Cnattingius *et al.*, 2013).

10. The effect of maternal employment status with overweight or obesity through exclusive breastfeeding

The result of this study showed that maternal employment status has an effect on overweight and obesity in toddlers through exclusive breastfeeding. Working mothers decrease the risk of exclusive breastfeeding so that leads to overweight/obesity in children.

Working women is one of the fastest causes of breastfeeding weaning processes, this is due to multidimensional effects such

as fatigue, practicality, lack of breastfeeding time, and the intensity of meeting with infants (Rollins *et al.*, 2016).

Mothers who plan to return to work on the day off of less than 6 weeks increase the risk by four times to stop the breastfeeding in an early time, it also deals with maternal psychological stress, uncooperative workplaces and the constraints in giving the breastmilk (Guendelman *et al.*, 2009).

Another study explains that mothers who return to work when the infant is less than 12 weeks reduce exclusive breastfeeding rate by 0.68 times compared to mothers with longer day off (Mirkovic *et al.*, 2014). According to Ogbuanu *et al.*, (2011) mothers with long day off and housewives increase the chances of exclusive breastfeeding in infants compared to mothers with short day off.

A study in Ghana showed that housewives increase exclusive breastfeeding by (84%) and formal working mothers by (16%). Housewives (informal employment) provide greater opportunities (91%) for frequent breastfeeding of more than eight times compared to mothers who work in the formal sector (9%). Most mothers who work in the formal sector do not bring their babies to work, and do not pump their breast milk, therefore, it increases the risk of problems in breastfeeding (Ward *et al.*, 2013; Binns, 2016; Nkrumah, 2017).

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