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THE EFFECT OF CHILDHOOD NUTRITIONAL STATUS CHANGES WITH PRE-DIABETES AND DIABETES RISK AMONG ADOLESCENTS: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

The first 1000 days of life and before the age of five years is a critical period of nutritional opportunity and vulnerabilitya. Only few have studies that trace individuals from childhood to adolescence examined the influence of childhood undernutrition on diabetes risk. This research was a retrospective cohort study using secondary data from IFLS (Indonesian Family Life Survey) involving 373 adolescents at IFLS-5 (2014) that folllowed at IFLS-3 (2000) and at IFLS-2 (1997). The effect of childhood undernutrition on the risk of pre-diabetes and diabetes in adolescents was analyzed using multinomial logistic regression. The results of this study showed that the prevalence of pre-diabetes was 12.6% and diabetes was 15.0%. The risk factor for pre-diabetes is frequent consumption of fast food (aOR=4.38). Meanwhile, recovering from stunting was a protective factor in adolescents (aOR=0.05). Risk factors for diabetes were stunting (aOR=2.71), deteriorated nutritional status during childhood (aOR=3.85), experienced wasting during childhood (aOR=3.55), and frequent fast food consumption (aOR=3.11). Meanwhile, vegetable consumption was a protective factor of diabetes (aOR=0.37). In conclusion, this study showed that childhood undernutrition on the risk of diabetes. Improvement point is through nutrition programs in childhood and adolescence.

KEYWORDS *Stunting, Wasting, Pre-Diabetes, Diabetes, Adolescents*

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INTRODUCTION

The first one thousand days of life (1000 days) is known as the window of opportunity because it is the golden period for optimal growth and development. After that, the period before the age of five years also becomes a vulnerable group requiring adequate nutrition attention. If not optimal, it will lead to malnutrition problems such as stunting and wasting. The prevalence of stunting in toddlers reaches 24.4% and wasting reaches 7.1%. Malnutrition has long-term impacts on the occurrence of non-communicable diseases such as diabetes (DeBoe *et al.* 2014; Kementerian PPN/ Bappenas 2018; Kemenkes RI 2021).

Diabetes is often only associated with adults, but the results of systematic reviews and meta-analyses showed that elevated blood sugar levels have been detected since adolescence (Daniel et al., 2020). The prevalence of diabetes in adolescents in Indonesia reaches 6.2% (Pulungan, 2018). In the other hand, adolescent period is the second window of opportunity (Unicef 2017). Diabetes is one of the four priority of non-communicable disease, which causes 236 thousand deaths in Indonesia, the sixth highest globally. The deaths occur before the age of sixty and it should be preventable *(International Diabetes Federation* 2022).

Diabetes is caused by risk factors that are both non-modifiable and modifiable. Non-modifiable risk factors include age, gender, family history, and ethnicity/race. Whereas modifiable risk factors such as smoking habits, physical activity, dietary habits, and alcohol consumption (World Health Organization, 2020). The results of the Global School-based Student Health Survey 2007-20015 showed an increase in the prevalence of obesity from 1.3% to 4.9%; reduction in vegetable consumption from 83.3% to 82.15%; decreased fruit consumption from 69.6% to 63.9%, decreased physical activity from 16.5% to 12.23%; increase in smoking habits from 7.9% to 10.6% (Health Research and Development Agency 2007; Health Research and Development Agency 2015). The Total Diet Study (2015) showed as much as 4.8%; 18.3% and 26.5% consumed sugar, sodium and fat in excess of the message of Minister of Health Regulation Number 30 of 2013 (Kemenkes RI 2014).

Research in Indonesia as a developing country has not explored much about the development of nutritional status from toddlers to adolescents and its relationship with diabetes. However, adolescence is a critical point for identifying the risk of diabetes to prevent complications in adulthood. Considering the high prevalence of undernutrition in Indonesia, the health development of children who have experienced malnutrition but have not recovered and children who have recovered from malnutrition problems may differ. Therefore, researchers are interested in analyzing the effect of childhood nutritional status changes on pre-diabetes and diabetes risk among adolescence. .

RESEARCH METHOD

Research Respondents

This study is a retrospective cohort study using secondary data from the Indonesian Family Life Survey (IFLS), which is a panel survey conducted by the

RAND Corporation and several research institutions in Indonesia, namely the Demographic Institute of the University of Indonesia, the Population Research Center at Gadjah Mada University, the Center for Population and Policy Studies at Gadjah Mada University, and SurveyMETER.

The baseline survey in 1993 was conducted in 13 provinces in Indonesia. The survey data used in this study are from surveys conducted in 1997 (IFLS-2), 2000 (IFLS-3), and 2014 (IFLS-5). The respondents' data used in this study are individual data that meet the inclusion criteria, namely: a. Individuals aged 0-24 months in 1997 (IFLS-2) and aged ≤60 months at follow-up in 2000 (IFLS-3); b. have data on date of birth, measurement date, gender, region of residence, adolescent smoking habits, physical activity, psychological health, sleep quality, frequency of food consumption, body weight, height, and complete HbA1C. The exclusion criteria for this study are: a. Aged over 19 years in 2014 (IFLS-5); b. TB/U z-score values are at extreme values (<-6.0 or >6.0) and BMI/U z-score (<-5.0 or >5.0). After data cleaning, out of a total of 1018 individuals aged 0-24 months in IFLS-2 (1997) and aged less than 60 months at follow-up in IFLS-3 (2000), 373 respondents were obtained who met the inclusion and exclusion criteria for further analysis.

Ethical Approval

This study uses secondary data from the Indonesian Family Life Survey (IFLS). Research data were obtained from survey data published by the RAND Corporation in surveys conducted in 1997 (IFLS-2), 2000 (IFLS-3), and 2014 (IFLS-5). The IFLS survey has obtained ethical approval from the Institutional Review Board (IRB) of the RAND Corporation in the United States with number S0064-06-01-CR01. Informed consent was obtained from all respondents before the interviews were conducted. The survey questionnaire consists of several booklets containing modules listed in sections.

Data Analysis

After data processing, data analysis was conducted using Stata 17 and IBM SPSS 25. Univariate analysis was conducted for each variable's characteristics and then presented in tables along with interpretations. Multivariate analysis was conducted to analyze the effect of independent variables on dependent variables. Multivariate analysis used multinomial logistic regression analysis to determine the effect of several independent variables on the dependent variable, which is the risk of Diabetes Mellitus. Multinomial logistic regression analysis was used because the dependent variable in this study has more than two categories.

RESULT AND DISCUSSION

Respondents in this study were adolescents in IFLS-5 (2014) who had been followed up since infancy, specifically in IFLS-2 (1997) at the age of 0-2 years and then in IFLS-3 (2000) at less than 5 years of age. Socio-demographic characteristics are presented in Table 1.

Table 1 shows the characteristics of respondents, nutritional status, and diabetes risk. Some respondents were male (50.7%), and some were 18 years old (53.6%). Adolescents in this study mostly belong to the late adolescent age group.

According to Sarwono (2016), late adolescents aged 18-21 years have distinct characteristics because they experience a strengthening period towards adulthood. In addition to physical changes (growth, hormonal changes, sexual development), there is a strengthening of lifestyle (diet, exercise, sleep habits, alcohol consumption, smoking), and mental health.

Based on lifestyle, most respondents are non-smokers (73.7%), but the rest are smokers (26.3%). The results of Jamal *et al.* (2020) study using data from the Global Youth Tobacco Survey in 2014 showed a rising trend in smoking habits not only among adults but also among adolescents, reaching 14.7%. Some respondents (50.4%) have active physical activity.

Table 1 Distribution of respondents based on socio-demographic characteristics

Variable	n=373	(%)
Gender		
Male	189	50,7
Female	184	49,3
Age		
17	57	15,3
18	200	53,6
19	116	31,3
Place of Residence		
Rural	140	37,5
Urban	233	62,5
Smoking Habit		
Non-smoker	275	73,7
Active smoker	98	26,3
Physical Activity		
Active	188	50,4
Less active	185	49,6
Psychological Health		
Not stressed (CESD-R10 < 10)	213	57,1
Stressed (CESD-R ≥ 10)	160	42,9
Sleep Quality		
Good	330	88,5
Poor	43	11,5
Instant Noodle Consumption		
Frequent (≥ 3 times/week)	137	36,7
Rarely (< 3 times/week)	236	63,3
Fast Food Consumption		
Frequent (≥ 3 times/week)	43	11,5
Rarely (<3 times/week)	330	88,5
Soft Drink Consumption		
Frequent (≥ 3 times/week)	58	15,5
Rarely (< 3 times/week)	315	84,5

Fried Food Consumption		
Frequent (≥ 3 times/week)	178	47,7
Rarely (< 3 times/week)	195	52,3
Sweet Food Consumption		
Frequent (≥ 3 times/week)	195	52,3
Rarely (< 3 times/week)	178	47,7
Vegetable Consumption		
Frequent (≥ 3 times/week)	117	31,4
Rarely (< 3 times/week)	256	68,6
Fruit Consumption		
Frequent (≥ 3 times/week)	309	82,8
Rarely (< 3 times/week)	64	17,2
Adolescent Nutritional Status		
Normoweight	283	75,9
Underweight	41	11,0
Overweight	40	10,7
Obese	9	2,4

Psychological health of respondents shows that some respondents (57.1%) have psychological health categorized as not stressed. The prevalence of emotional mental disorders in the age group of 15-24 years according to Riskesdas 2013 based on the Self-Reporting Questionnaire-20 is 5.6%. Most respondents (88.5%) have good sleep quality.

The frequency of consumption of respondents in this study is seen from the frequency of consumption of Less Healthy Foods (LHF), namely instant noodles, fast food, soft drinks, fried foods, and sweets. According to (Hill-Briggs et al., 2021), LHF consumption is a risk factor for diabetes in adolescents. The list of these foods is classified as less healthy because they are high in sodium, saturated fat, sugar, low in fiber, vitamins, and minerals. Some respondents (63.3%) rarely consume instant noodles, most (88.5%) rarely consume fast food, most (84.5%) rarely consume soft drinks, some (52.3%) rarely consume fried foods, and some (52.3%) often consume sweets. Rafiony *et al.* (2015) study results show a relationship between the frequency of fast food and soda consumption with obesity in adolescents. On the other hand, most respondents (68.6%) rarely consume fast food, and most respondents (82.8%) often consume fruit.

The nutritional status of respondents during adolescence mostly (75.9%) falls into the category of good nutritional status. However, there are still respondents who experience malnutrition problems (11%), overnutrition (10.7%), and obesity (2.4%). In line with the results of Riskesdas in 2013, it shows that in the age group of 16-18-year-old adolescents, the prevalence of nutritional status (BMI/U) with normal categories is 83.2%, but there are still cases of malnutrition reaching 9.4%, overnutrition 5.7%, and obesity 1.6% (Kemeterian Kesehatan RI, 2013). Most respondents (72.4%) have HbA1C levels in the normal category. On the other hand, it is known that 12.6% of respondents are in the pre-Diabetes category, and 15.0% of respondents have Diabetes. Based on the literature review conducted by Ulya *et*

al. (2023), a description of risk factors related to diabetes mellitus in adolescents was determined.

The change in nutritional status during infancy becomes an independent variable in the research presented in Table 2.

Table 2. Distribution of respondents based on changes in nutritional status during childhood

Nutritional Status Change	Number of Respondents (n=373)	Percentage (%)
Nutritional status change (TB/U z-score)		
Normal	143	38,3
Stunting	79	21,2
Recovered	48	12,9
Deteriorated	103	27,6
Nutritional status change (BMI/U z-score)		
Normal	309	82,8
Wasting	9	2,4
Recovered	37	9,9
Deteriorated	18	4,8

Changes in respondents' nutritional status during infancy based on TB/U z-score indicators show that 38.3% of respondents have normal nutritional status. This indicates that during infancy, these respondents did not have nutritional problems. On the other hand, 27.6% of respondents experienced a change in nutritional status during infancy to deteriorated. This indicates that infants who had normal nutritional status at ages 0-2 years changed to stunting after ages 3-5 years. About 21.2% of respondents remained stunted during follow-up. However, 12.9% of respondents experienced nutritional status recovery during infancy. In addition to using the TB/U z-score indicator to assess respondents' stunting status, the research also uses the BMI/U z-score indicator to assess respondents' wasting status. Based on this indicator, most respondents (82.8%) during follow-up had normal nutritional status. It was found that 2.4% of respondents remained wasting. Furthermore, 9.9% of respondents experienced nutritional status recovery during infancy. However, there are still respondents who experienced a decrease in nutritional status during infancy (4.8%).

In this study, an analysis of the relationship between changes in nutritional status during infancy and the risk of diabetes in adolescents was conducted, as presented in Table 3. The results show that adolescents who remain stunted during follow-up from infancy have a 2.71 times greater risk of developing Diabetes Mellitus during adolescence compared to adolescents who had normal nutritional status during infancy (aOR 2.71 95%CI 1.15-6.43) p=0.002. This indicates the long-term impact of stunting during infancy on the risk of Diabetes Mellitus in adolescents. Martins dan Sawaya (2016) study states that the effects of malnutrition in the first year of life affect glucose metabolism, associated with hyperinsulinemia and decreased insulin sensitivity. This can have negative consequences as body mass index increases

from adolescence to adulthood. This is related to the assessment results of HOMA-B (Homeostatic Model Assessment Beta-cell Function) and HOMA-S (Homeostatic Model Assessment for Insulin Sensitivity) which show changes in insulin production and sensitivity in stunted children. The pancreatic beta cell function in stunted children results in lower insulin production and greater sensitivity compared to normal children. In stunted individuals, the body does not effectively respond to insulin, leading to increased insulin production over time, which in the long term affects the occurrence of Diabetes.

Table 3 The effect of Childhood Nutritional Status Changes on Diabetes Risk

Variable	Pre-diabetes		Diabetes	
	OR (95% CI)	*p-value*	OR (95% CI)	*p-value*
Nutritional status change during infancy (TB/U z-score)	-	-	-	-
Normal	1,00 (0,44-2,30)	0,99	2,71 (1,15-6,43)	0,02*
Stunting	0,21 (0,05-0,95)	0,04*	0,18 (0,02-1,45)	0,10
Recovered	0,89 (0,39-2,01)	0,78	3,85 (1,75-8,45)	0,001*
Deteriorated				
Nutritional status change during infancy (BMI/U z-score)				
Normal	-	-	-	-
Wasting	1,86 (0,38-8,96)	0,44	3,55 (0,46-1,49)	0,04*
Recovered	0,51 (0,14-1,82)	0,30	0,50 (0,15-1,62)	0,25
Deteriorated	0,36 (0,04-3,00)	0,34	1,21 (0,29-4,99)	0,79
Sleep Quality				
Good	-	-	-	-
Poor	2,15 (0,85-5,41)	0,10	2,31 (0,95-5,59)	0,06
Vegetable Consumption				
Rare	-	-	-	-
Frequent	1,20 (0,61-2,36)	0,58	0,37 (0,17-0,83)	0,01*
Fast Food Consumption				
Frequent	-	-	-	-
Rarely	4,38 (1,62-11,84)	0,004*	3,11 (1,17-8,26)	0,02*

Note: Multinomial logistic regression test adjusted for psychological health, smoking habits, nutritional status, soft drink consumption, fried food consumption. *Significant p-value if $p<0.05$

Other results show that stunted infants are associated with reduced levels of growth factors synthesis such as IGF-1. Even a temporary reduction of 50% in calories or 33% in protein availability can result in a reversible decrease in IGF-1 concentration. Decreased IGF-1 levels lead to a secondary increase in growth hormone levels through negative feedback from low levels of IGF-1 on pituitary GH synthesis. The end result of metabolism is a substrate shift from growth to metabolic homeostasis. The metabolic effects of growth hormone, which do not depend on IGF-1, will clearly be adaptive in response to decreased substrate intake. This includes

increased lipolysis and mobilization of free fatty acids from adipose tissue stores and inhibition of glucose uptake by muscle tissue (Bartz *et al.* 2014; Hawkes *et al.* 2017).

Recovery from stunting before the age of 5 years is a protective factor against the occurrence of pre-hypertension (aOR=0.21 95%CI 0.05-0.95). Consistent with the study by Roth *et al.* (2015), the first 2 years of age require high nutritional needs for growth and development. Nutritional improvements after the age of 2 years affect subsequent growth and development. The results of Isanaka *et al.* (2019) study state that accelerated height growth during childhood can reduce the risk of growth failure.

Vegetable consumption is a protective factor against diabetes occurrence (aOR 0.37 95%CI 0.17-0.83; p=0.01). This result is consistent with previous studies stating a strong relationship with glucose regulation and fruit and vegetable consumption in a cross-sectional study with a population at risk of diabetes (Dabhi et al., 2023). In addition, the type and quality of vegetables and fruits consumed are also related to high blood sugar disorders, with high intake of green leafy vegetables or dark yellow vegetables associated with a reduced risk of diabetes.

Another factor showing a significant relationship with diabetes occurrence is fast food consumption. Adolescents who frequently consume fast food have a 3.11 times greater risk of diabetes compared to adolescents who rarely consume fast food (aOR 3.11 95%CI 1.17-8.26; p=0.02). Consistent with previous studies showing that adolescents who have a habit of consuming fast food have a 2.96 times higher risk compared to adolescents who do not have a habit of consuming fast food (OR 2.96 95% CI: 1.02–8.63). This is related to the high sugar and fat content in fast food, which can increase insulin resistance, leading to increased blood pressure. In addition, fast food generally contains little fiber. Fiber plays a role in blood sugar balance (Asghari et al., 2015).

Stength of this study is its longitudinal-retrospective cohort surudy design that gives link effect between nutritional status during childhood and its long term effect of diabetes risk among adolescent. The availability of socio-demografhics, life style, adolescent nutrition status, dietary habit data collected on this study can enable to account confounding factors. Measuring hba1c levels can reflect the average blood sugar levels over the last 3 months. This study has some limitation because of limited data such as puberty status, family history of diabetes, and data another data from childhood such as birth weight and infection status.

CONCLUSION

The risk of Diabetes Mellitus, as many as 12.6% of respondents are categorized as pre-Diabetes and 15.0% of respondents experience Diabetes. Adolescents who remain stunted during follow-up from infancy are at 2.71 times greater risk of experiencing Diabetes Mellitus during adolescence compared to adolescents who had normal nutritional status during infancy. Adolescents who frequently consume fast food have a 3.11 times greater risk of diabetes compared to adolescents who rarely consume fast food (aOR 3.11, 95%CI 1.17-8.26; p=0.02). Vegetable consumption is a protective factor against diabetes occurrence (aOR 0.37, 95%CI 0.17-0.83; p=0.01). Nutritional status during infancy affects the

occurrence of pre-diabetes and diabetes in adolescent respondents, making infancy a vulnerable period for nutritional problems and requiring appropriate interventions to support their future health.

REFERENCES

Akseer N, Mehta S, Wigle J, Chera R, Brickman ZJ, Sorichetti B, Vandermorris A. 2020. Non-communicable diseases among adolescents : current status , determinants , interventions and policies. *BMJ Open*. 20:1–20. doi:https://doi.org/10.1186/s12889-020-09988-5.

Asghari G, Yuzbashian E, Mirmiran P, Mahmoodi B. 2015. Fast Food Intake Increases the Incidence of Metabolic Syndrome in Children and Adolescents : Tehran Lipid and Glucose Study. *PLoS One*. 10(10):1–11. doi:10.1371/journal.pone.0139641.

Awuchi CG, Echeta CK, Igwe VS. 2020. Diabetes and the Nutrition and Diets for Its Prevention and Treatment : A Systematic Review and Dietetic Perspective Diabetes and the Nutrition and Diets for Its Prevention and Treatment : A Systematic Review and Dietetic Perspective. *Am Assoc forScience Technol*. 6(1).

Bartz S, Mody A, Hornik C, Bain J, Muehlbauer M, Kiyimba T, Kiboneka E, Stevens R, Bartlett J, Peter JVS, *et al*. 2014. Severe Acute Malnutrition in Childhood : Hormonal and Metabolic Status at Presentation , Response to Treatment , and Predictors of Mortality. *J Clin Endocrinol Metab*. 99(6):2128–2137. doi:10.1210/jc.2013-4018.

Dabhi KN, Gohil N V, Tanveer N, Hussein S, Pingili S, Makkena K, Jaramillo AP, Awosusi BL, Ayyub J, Nath TS. 2023. Assessing the Link Between Statins and Insulin Intolerance : A Systematic Review. *Cureus*. 15(7). doi:10.7759/cureus.42029.

Daniel RA, Id PH, Prasad M, Kant S. 2020. Prevalence of hypertension among adolescents (10-19 years) in India : A systematic review and meta-analysis of cross- sectional studies. *PLoS One*. 15(10):1–21. doi:10.1371/journal.pone.0239929.

DeBoe MD, Lima AAM, Orí RB, Scharf RJ, Moore SR, Luna MA, Guerrant RL. 2014. Early childhood growth failure and the developmental origins of adult disease. *Nutr Re*. 70(11):1–7. doi:10.1111/j.1753-4887.2012.00543.x.Early.

Hawkes CP, Grimberg A, Health C. 2017. Insulin-Like Growth Factor-I is a Marker for the Nutritional State. *Pediatr Endocrinol Rev*. 13(2):499–511.

Health Research and Development Agency W. 2007. Global School - Based Student Health Survey (Gshs) Indonesia Table of Contents. Jakarta.

Health Research and Development Agency W. 2015. Global School-based Student Health Survey Results: 2015. Jakarta.

Hill-Briggs F, Adler NE, Berkowitz SA, Chin MH, Gary-Webb TL, Navas-Acien A, Thornton PL, Haire-Joshu D. 2021. Social determinants of health and diabetes: A scientific review. *Diabetes Care*. 44(1):258–279. doi:10.2337/dci20-0053.

Hovestadt I, Kiess W, Lewien C, Willenberg A, Poulain T, Meigen C, Körner A, Vogel M. 2022. HbA1c percentiles and the association between BMI, age,

gender, puberty, and HbA1c levels in healthy German children and adolescents. *Pediatr Diabetes*. 23(2):194–202. doi:10.1111/pedi.13297.

International Diabetes Federation. 2022. *Annual Report 2022*. USA: International Diabetes Federation.

Isanaka S, Hitchings MDT, Grais RF. 2019. Linear growth faltering and the role of weight attainment : Prospective analysis of young children recovering from severe wasting in Niger. *Matern Child Nutr*., siap terbit.

Kemenkes RI. 2014. *Studi Diet Total 2014*. Jakarta: Kemenkes RI.

Kemenkes RI. 2021. *Buku Saku Hasil Studi Gizi Indonesia (SSGI) 2021*. Jakarta: Kemenkes RI.

Kementerian PPN/ Bappenas. 2018. Pedoman Pelaksanaan Intervensi Penurunan Stunting Terintegrasi di Kabupaten/Kota. *Rencana Aksi Nas dalam Rangka Penurunan Stunting Rembuk Stunting*. November:1–51. https://www.bappenas.go.id.

Kemeterian Kesehatan RI. 2013. *Laporan Nasional Riskesdas Tahun 2013 dalam Angka*. Jakarta: Kemenkes RI.

Martins PA, Sawaya AL. 2006. Evidence for impaired insulin production and higher sensitivity in stunted children living in slums. *Br J Nutr*. 95:996–1001. doi:10.1079/BJN20061754.

Pulungan AB. 2018. Type 2 diabetes mellitus in children and adolescent : an Indonesian perspective. *Ann Pediatr Endocrinol Metab*. 23:119–125. doi:https://doi.org/10.6065/apem.2018.23.3.119.

Roth DE, Krishna A, Leung M, Shi J, Bassani DG, Barros AJD, Bill F, Foundation MG. 2015. Articles Early childhood linear growth faltering in low-income and middle-income countries as a whole-population condition : analysis of 179 Demographic and Health Surveys from 64 countries (1993 – 2015). *Lancet Glob Heal*. 5(12):e1249–e1257. doi:10.1016/S2214-109X(17)30418-7.

Sarwono SW. 2016. *Psikologi Remaja*. Edisi revi. Depok: Rajawali Pers.

UNICEF. 2017. *The Adolescent Brain: A second window of opportunity*. Florence: United Nations Children's Fund (UNICEF). www.unicef-irc.org.

World Health Organization. 2020. *Noncommunicable diseases: progress monitor 2020*. Geneva: World Health Organization.