Carotid intima-media thickness, hypertension, and dyslipidemia in obese adolescents

by Nur Aisiyah Widjaja
Research

Carotid intima-media thickness, hypertension, and dyslipidemia in obese adolescents

Nur Asiaiyah Widjaja1,2, Roedi Irawan1, Rendi Aji Prihaningtyas1, Melty Ardiana3, Meta Herdiana Hanindita1

1Child Health Department, Faculty of Medicine Universitas Airlangga, Dr. Soetomo General Hospital, Surabaya, Indonesia, 2Medical Doctoral Program Student, Faculty of Medicine Universitas Airlangga, Dr. Soetomo General Hospital, Surabaya, Indonesia, 3Cardiology and Vascular Medicine Department, Faculty of Medicine Universitas Airlangga, Dr. Soetomo General Hospital, Surabaya, Indonesia

*Corresponding author: Nur Asiaiyah Widjaja, Child Health Department, Faculty of Medicine Universitas Airlangga, Dr. Soetomo General Hospital, Surabaya, Indonesia

Key words: Obesity, adolescents, CIMT, dyslipidemia, hypertension

Received: 29/01/2019 - Accepted: 30/10/2019 - Published: 07/11/2019

Abstract

Introduction: obesity is a global health problem with growing prevalence in developing countries. Obesity causes chronic inflammation due to imbalances between pro- and anti-inflammatory cytokines. This causes metabolic complications such as dyslipidemia, hypertension, and cardiovascular disorder. Carotid intima-media thickness (CIMT) is a predictor of atherosclerosis which can be measured easily and non-invasively. Early detection of cardiovascular diseases in obese adolescents at risk is hoped to improve outcomes. Methods: this is a cross-sectional study on obese adolescents aged 13-16 year old at Pediatric Clinic of Dr. Soetomo General Hospital. Obesity is defined as Body mass index higher than 95th percentiles according to CDC (2000). Dyslipidemia is diagnosed when either an increase in cholesterol, LDL, triglyceride or a decrease in HDL level is found, as recommended by NCEP and American Academy of Pediatrics. Hypertension is defined as an increase of blood pressure > 95 according to age and gender. The differences of CIMT based on dyslipidemia, hypertension, and gender were analyzed with Wilcoxon Mann Whitney with significant p value (p < 0.005). Results: this study included 59 obese adolescents, consisting of 32 (54.2%) male adolescents and 35 (59.3%) female adolescents. Dyslipidemia was found on 38 (64.4%) adolescents and hypertension was found on 35 (59.3%) adolescents. No difference of CIMT was found between obese adolescents with and without dyslipidemia and with and without hypertension based on gender (p > 0.05). Conclusion: No difference of CIMT based on gender between adolescents aged below 18. The high number of dyslipidemia and hypertension in obese adolescents need an early detection of cardiovascular complication.

Pan African Medical Journal. 2019;34:134. doi:10.11604/pamj.2019.34.134.18309

This article is available online at: http://www.panafrican-med-journal.com/content/article/34/134/full/

© Nur Asiaiyah Widjaja et al. The Pan African Medical Journal - ISSN 1937-8688. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Pan African Medical Journal – ISSN: 1937-8688 (www.panafrican-med-journal.com)

Published in partnership with the African Field Epidemiology Network (AFENET). (www.afenet.net)
Introduction

Obesity is a global problem which increases the risk of early death. Obesity causes chronic inflammation through an increase in the production of pro-inflammatory cytokines, which causes metabolic diseases [1]. Adolescents who have risk factors such as obesity, dyslipidemia, hypertension, and diabetes mellitus have higher risk of cardiovascular diseases as adults [2]. Metabolic syndrome increases mortality risk up to 1.5 times [3]. The process of atherosclerosis starts early in obese children and adolescents. Carotid intima media thickness (CIMT) is a subclinical marker of atherosclerosis [2]. Measurement of CIMT is a modality that could be used to assess cardiovascular risk factors non-invasively and has been done since 1980s. Obese adolescents with cardiovascular risk factors have higher CIMT [4]. Majority of study in CIMT as a risk factor of cardiovascular disease are performed in adult and developed country. In developing country, there is a limited study in CIMT of obese adolescents. The aim of this study is to analyze the difference of CIMT between obese adolescents with and without dyslipidemia and with and without hypertension based on gender.

Methods

A cross-sectional study was done on obese adolescents aged 13-16 year old at Pediatric Clinic Dr. Soetomo General Hospital, Surabaya, Indonesia. Subjects who had Body Mass Index higher than 95th percentile based on BMI percentile in CDC curve according to age and sex were included in this study. Subjects who had consumed corticosteroids within 6 months before study, underwent hormonal therapy or consumed dyslipidemia drugs within 3 months before study, smoked, consumed alcohol, or had endocrine disorder were excluded.

Anthropometry measurement, including body weight and height, was done by trained health workers. Body weight was measured without footwear, accessories, and with clothes that weighed less than 0.1 kg using digital scale (Seca, Germany). Body height was measured without footwear or headwear in erect position using stadiometer (Seca, Germany). Body mass index (BMI) was calculated with the formula of body weight (kg) divided by squared body height (meter). Obesity is defined as BMI higher than 95th percentile according to age and gender based on CDC curve (2000). Blood pressure was measured in sitting position after the subject had rested for 10 minutes. Hypertension is defined as blood pressure higher than 95th percentile according to age and gender.

CIMT measurement was done using high-resolution B-mode ultrasonography (Toshiba, Japan) by a cardiologist. Subjects were examined in supine position, with neck minimally extended and probe placed in anterolateral position. Imaging was done on the left common carotid artery. Lipid profile test was done using ELISA method. Triglyceride test was done using Autosera S TG-N Kit (Sekisui Medical Co., Ltd., Japan). LDL, HDL, and total cholesterols tests were done using Cholestest®LDL, Cholestest® HDL, dan Puranauto®S CHOL (Sekisui Medical Co., Ltd., Japan). Dyslipidemia is diagnosed when either an increase in cholesterol, LDL, triglyceride or a decrease in HDL level is found, as recommended by NCPE and American Academy of Pediatrics.

Statistic methods: quantitative variables are described in mean and standard deviation. CIMT differences based on dyslipidemia, hypertension, and gender were analyzed using Wilcoxon Mann Whitney with significant p of < 0.05. Analysis was done using SPSS. This study was approved by Ethical Committee in health research of Dr. Soetomo General Hospital (ref. No. 0698/KEPK/X/2018). Parents of the subjects were provided with an informed consent before study. All data obtained from the subject were anonymized.

Results

This study included 59 obese adolescents, consisting of 32 (54.2%) male adolescents and 35 (59.3%) female adolescents. Dyslipidemia was found on 38 (64.4%) adolescents and hypertension was found on 35 (59.3%) adolescents. Characteristics of the subjects are shown in Table 1. There was no difference in CIMT between female and male adolescents (mean = 0.51 ± 0.12 vs 0.51 ± 0.07; p = 0.50). There was also no difference in CIMT between obese adolescents with or without dyslipidemia (female p = 0.974; male p = 0.313) and with or without hypertension (female p = 0.321; male p = 0.833) based on gender (Table 2).
Discussion

Obesity is related to inflammation as a result of imbalances between pro- and anti-inflammatory cytokines [3]. Inflammation in obesity is marked by an increase in TNF and hsCRP [6]. Storage of abdominal adipose tissue causes cell dysfunction and cardiometabolic diseases in adulthood [7, 8]. The higher the body fat percentage, the higher the risk of cardiovascular diseases [9]. Atherosclerosis process starts early among children and adolescents with obesity. CIMT is a subclinical atherosclerosis marker [2]. Obese adolescents have higher CIMT compared to adolescents with normal BMI [10]. Previous study on healthy subjects showed no difference in CIMT between female and male adolescents, but CIMT tends to increase after 10 years of age [11]. A study on obese adolescents showed no difference in CIMT between males and females, but an association between CIMT and arterial stiffness was found, especially among female adolescents [12]. Results from this study is in accordance with that study. When a child turns 10 year old, puberty starts and hormonal change could cause changes in body fat composition [13].

In this study, majority of subject had dyslipidemia and hypertension (Table 1). CIMT increases when dyslipidemia, hypertension, and diabetes mellitus is present [14]. Obese adolescents have a 6.5 times higher risk of pre-hypertension or hypertension [15]. Blood pressure has direct effect on CIMT [4]. Hypertension causes hypertrophy of the tunica media of blood vessels, therefore increasing CIMT [16].

However, another study on children and adolescents showed that there is no difference in CIMT between subjects with and with metabolic syndromes [2]. This study did not find a difference in CIMT between subjects with and without hypertension based on gender. Previous study mentioned that CIMT is associated with age, but not blood pressure [10]. No difference in CIMT between subjects with and without dyslipidemia based on gender was found (Table 2). Previous study reported that obesity could affect BMI if cardiovascular risk factor, such as dyslipidemia, is present [4]. High level of triglyceride is associated with increased CIMT [2]. Gender does not affect the wall of normal common carotid artery until the age of 18 with progressive thickening of the blood vessel's wall [17].

There were some limitation in this study. First, there was a limited subject in this study. Second, the low sensitivity of high-resolution B-mode ultrasonography could affect CIMT measurement and might not be able to detect small differences, as a previous study [11]. There was still a limited study in CIMT of obese adolescence in developing country. Detecting of early risk of cardiovascular disease in obese adolescents are needed. Further studies with a greater number of subject and control subject who has a normal BMI are needed to assess the risk of cardiovascular disease using CIMT in obese adolescents.

Conclusion

No difference in CIMT was found between obese adolescents with and without hypertension and with and without dyslipidemia based on gender. Age below 18 does not affect CIMT thickness may due to unstarted progressive thickening of the wall of the common carotid artery. There was a higher number of dyslipidemia and hypertension in obese adolescents. The further study with a greater number of subject and control subject are needed to assess the risk of cardiovascular disease in obese adolescents.

What is known about this topic

- No difference in CIMT was found between obese adolescents based on gender;
- Obese adolescents can suffered from hypertension and dyslipidemia;
- Hypertension and dyslipidemia can influence the CIMT.

What this study adds

- No difference in CIMT was found between obese adolescents with and without hypertension and with and without dyslipidemia based on gender;
- Unstarted progressive thickening of the wall of the common carotid artery at the age below 18 can cause no differences in CIMT;
- Prevalence of dyslipidemia and hypertension in obese adolescents are high in developing country, such as Indonesia.

Competing interests

The authors declare no competing interests.
Authors’ contributions

Nur Aisyah Widjaja: conceived and design analysis, collect the data, contributed data and analysis tool, performed the analysis, drafting the article, wrote the paper.راءدي إراوان: conceived and design analysis, collect the data, contributed data and analysis tool, performed the analysis, drafting the article, wrote the paper. مليب أردانا، متى أردانا هانيندتا: collect the data. رندى أجي اريبانينجيا: collect the data, performed the analysis, drafting the article, wrote the paper. All the authors read and approved to final version of the manuscript.

Acknowledgments

Grateful to KNH research programs department for funding this study and providing relevant resources. The funding did not include manuscript publication grants.

Tables

Table 1: characteristics of the study’s subjects
Table 2: correlation between variables

References

1. Castro AM, Macedo-de la Concha LE, Pantoja-Meléndez CA. Low-grade inflammation and its relation to obesity and chronic degenerative diseases. Revista Médica del Hospital General de México. 2017;80(2):101–105. Google Scholar

2. Fang J, Zhang JP, Luo CX, Yu XM, Lv LQ. Carotid intima-media thickness in childhood and adolescent obesity relations to abdominal obesity, high triglyceride level and insulin resistance. Int J Med Sci. 2010 Aug 18;7(5):278-83. PubMed | Google Scholar

3. Engin A. The Definition and Prevalence of Obesity and Metabolic Syndrome. In: Engin AB, Engin A, editors. Obesity and Lipotoxicity. Cham. Springer International Publishing: 1–17. 2017.

4. Gao Z, Khoury PR, McCoy CE, Shah AS, Kimball TR, Dolan LM et al. Adiposity has no direct effect on carotid intima-media thickness in adolescents and young adults: Use of structural equation modeling to elucidate indirect & direct pathways. Atherosclerosis. 2016 Mar;246:29-35. Epub 2015 Dec 8. PubMed | Google Scholar

5. Todendi PF, Posuelo LG, Klinger EI, Reuter CP, Burgos MS, Mora DJ et al. Low-grade inflammation markers in children and adolescents: Influence of anthropometric characteristics and CRP and IL6 polymorphisms. Cytokine. 2016 Dec;88:177-183. PubMed | Google Scholar

6. Ayoub M, Zouaoui C, Grina N, Kochkar R, Stambouli N, Bouguerra C et al. Correlation between Dietary Intake and Inflammatory Biomarkers in a Tunisian Obese Group. Journal of Biosciences and Medicines. 2015;03(11):108–113. Google Scholar

7. Weber DR, Levitt Katz LE, Zemel BS, Gallagher PR, Murphy KM, Dumsor SM et al. Anthropometric measures of abdominal adiposity for the identification of cardiometabolic risk factors in adolescents. Diabetes Res Clin Pract. 2014 Mar;103(3):e14-7. Epub 2014 Jan 8. PubMed | Google Scholar

8. Stelano AE, Katzmarzyk PT. Ethnic and sex differences in body fat and visceral and subcutaneous adiposity in children and adolescents. Int J Obes (Lond). 2012 Oct;36(10):1261-9. Epub 2012 Jun 19. PubMed | Google Scholar

9. Going SB, Lohman TG, Cussler EC, Williams DP, Morrison JA, Horn PS. Percent body fat and chronic disease risk factors in U.S. children and youth. Am J Prev Med. 2011 Oct;41(4 Suppl 2):S77-86. PubMed | Google Scholar

10. Stabouli S, Kotsis V, Karagianni C, Zakopoulos N, Konstantopoulos A. Blood pressure and carotid artery intima-media thickness in children and adolescents: the role of obesity. Hellenic J Cardiol. 2012 Jan-Feb;53(1):41-7. PubMed | Google Scholar
11. Baroncini LAV, Sylvestre L de C, Pecoits Filho R. Assessment of Intima-Media Thickness in Healthy Children Aged 1 to 15 Years. Arq Bras Cardiol. 2016 Apr;106(4):327-32. Epub 2016 Mar 8. PubMed | Google Scholar

12. Webermuß H, Pirzer R, Böhm B, Dalla Pozza R, Netz H, Oberhofer R. Intima-media thickness and arterial function in obese and non-obese children. BMC Obes. 2016 Jan 9;3:2. eCollection 2015. PubMed | Google Scholar

13. Böhm B, Hartmann K, Buck M, Oberhofer R. Sex differences of carotid intima-media thickness in healthy children and adolescents. Atherosclerosis. 2009 Oct;206(2):458-63. Epub 2009 Mar 25. PubMed | Google Scholar

14. Le J, Zhang D, Menees S, Chen J, Raghuveer G. "Vascular Age" Is Advanced in Children With Atherosclerosis-Promoting Risk Factors. Circulation: Cardiovascular Imaging. 2010;3(1):8-14. Google Scholar

15. Su T-C, Liao C-C, Chien K-L, Hsu SH-J, Sung F-C. An Overweight or Obese Status in Childhood Predicts Subclinical Atherosclerosis and Prehypertension/Hypertension in Young Adults. J Atheroscler Thromb. 2014;21(11):1170-82. Epub 2014 Jul 16. PubMed | Google Scholar

16. Baroncini LAV, Sylvestre L de C, Baroncini CV, Pecoits Filho R. Assessment of Carotid Intima-Media Thickness as an Early Marker Of Vascular Damage In Hypertensive Children. Arq Bras Cardiol. 2017 May;108(5):452-457. Epub 2017 Apr 20. PubMed | Google Scholar

17. O'Leary DH, Bots ML. Imaging of atherosclerosis: carotid intima-media thickness. Eur Heart J. 2010 Jul;31(14):1682-9. Epub 2010 Jun 11. PubMed | Google Scholar

---

| Table 1: characteristics of the study’s subjects |
|-----------------------------------------------|
| Variable              | Mean ± SD       |
| Body weight (kg)      | 80.77 ± 13.35   |
| Body height (cm)      | 158.76 ± 7.12   |
| Body mass index (kg/m²)| 31.99 ± 3.67   |
| CIMT (mm)             | 0.51 ± 0.10     |

| Table 2: correlation between variables |
|---------------------------------------|
| Variable          | Sex | N   | CIMT    | p    |
| Hypertension      |     |     |        |      |
| Male              | 20  | 0.53 ± 0.08 | 0.033 |
| Female            | 15  | 0.53 ± 0.14 | 0.321 |
| Dyslipidemia      |     |     |        |      |
| Male              | 24  | 0.53 ± 0.79 | 0.313 |
| Female            | 14  | 0.56 ± 0.14 | 0.974 |

SD = Standard Deviation
## Carotid intima-media thickness, hypertension, and dyslipidemia in obese adolescents

### Originality Report

| Similarity Index | Internet Sources | Publications | Student Papers |
|------------------|------------------|--------------|---------------|
| 23%              | 15%              | 21%          | 0%            |

### Primary Sources

1. nrl.northumbria.ac.uk
   - Internet Source
   - 2%

2. www.scielo.br
   - Internet Source
   - 2%

3. www.hindawi.com
   - Internet Source
   - 1%

4. Bereket Beyene Gebre, ZEWDE OLTAYE OCHE.
   "MEDICATION ADHERANCE AND ITS ASSOCIATED FACTORS AMONG DIABETES PATIENTS HAVING FOLLOW UP IN DIABETIC CLINIC AT HAWASSA UNIVERSITY COMPRENSIVE SPECIALIZED HOSPITAL."
   - Research Square, 2019
   - 1%

5. Małgorzata Waluś-Miarka, D. Czarnecka, W. Wojciechowska, M. Kloch-Badełek et al.
   "Carotid Plaques Correlates in Patients With Familial Hypercholesterolemia"
   - Angiology, 2015
   - 1%
| Rank | Title                                                                 | Source Details                        |
|------|----------------------------------------------------------------------|--------------------------------------|
| 6    | Mahendra Tri Arif Sampurna, Kinanti A. Ratnasari, Zahra S. Irawan, Risa - Etika et al. "Evaluation of A Mobile Application Tool (BiliNorm) To Improve Care for Newborns with Hyperbilirubinemia in Indonesia", Research Square, 2020 | Publication                           |
| 7    | link.springer.com                                                   | Internet Source                      |
| 8    | "Rehabilitation interventions in the patient with obesity", Springer Science and Business Media LLC, 2020 | Publication                           |
| 9    | Pediatric Hypertension, 2013.                                        | Publication                           |
| 10   | pagepress.org                                                        | Internet Source                      |
| 11   | synapse.koreamed.org                                                 | Internet Source                      |
| 12   | "Pediatric Metabolic Syndrome", Springer Science and Business Media LLC, 2012 | Publication                           |
| 13   | bmcplantbiol.biomedcentral.com                                      | Internet Source                      |
| 14   | e-sc.org                                                            | Internet Source                      |
|   | Internet Source                                                                 |   |
|---|---------------------------------------------------------------------------------|---|
|15 | scholarworks.iupui.edu                                                          | 1%|
|16 | "Pediatric Obesity", Springer Science and Business Media LLC, 2018              | 1%|
|17 | Liz Andréa Villela Baroncini, Lucimary de Castro Sylvestre, Roberto Pecoits Filho.  "Assessment of Intima-Media Thickness in Healthy Children Aged 1 to 15 Years", Arquivos Brasileiros de Cardiologia, 2016 | 1%|
|18 | peerj.com                                                                       | 1%|
|19 | Wossenseged Lemma, Daniel Tarekegn, Meseret Birhanie. "Impact of intestinal helminthes infections on stunting, wasting, normal biochemical and hematological values on school children in Gondar town, Ethiopia.", Research Square, 2019| 1%|
|20 | www.jcrpe.org                                                                   | 1%|
|21 | Seyi Samson Enitan, Olayimika Kehinde Adebola, Esther Ngozi Adejumo, Grace Elejo Itodo et al. "Prevalence of Hepatitis B and C Virus Infection among Students of a Private Tertiary Institution in South-Western Nigeria", | <1%|
A Andrianto, Adityo Basworo, Ivana Purnama Dewi, Budi Susetio Pikir. "Expression of SSEA4 and TRA1-60 as Marker of Induced Pluripotent Stem Cells by Small Molecule Compound VC6TFZ on Peripheral Blood Mononuclear Cell", Cold Spring Harbor Laboratory, 2020

Esra Yazarlı, Rukiye Ünsal Saç, Betül Şimşek, Özlem Engiz, Yıldız Dallar Bilge, Bülent Alioğlu. "The relation between increased carotid intima - media thickness with fibrin monomers in obese Children", International Journal of Clinical Practice, 2021

Yvan Mivelaz, Stefano Di Bernardo, Tatiana Boulos Ksontini, Milan Prsa, Yvan Vial, Arnaud Chiolero, Nicole Sekarski. "Feasibility and reliability of carotid intima–media thickness measurements in nonsedated infants", Journal of Hypertension, 2016
|   | Source                                      | Percentage |
|---|---------------------------------------------|------------|
| 27 | hdl.handle.net                              | <1%        |
| 28 | journals.plos.org                           | <1%        |
| 29 | www.degruyter.com                           | <1%        |
| 30 | www.ijphrd.com                              | <1%        |
| 31 | www.scirp.org                               | <1%        |
| 32 | Hyo Hyun Yoo, Mi Kyung Kim, Yoo Sang Yoon, Keun Mi Lee, Jong Hun Lee, Seung-Jae Hong, Jung –Sik Huh, Won Kyun Park. "Changes in the accreditation standards of medical schools by the Korean Institute of Medical Education and Evaluation from 2000 to 2019", Journal of Educational Evaluation for Health Professions, 2020 | <1%        |
| 33 | Nadia Hamjane, Fatiha Benyahya, Naima Ghailani Nourouti, Mohcine Bennani Mechita, Amina Barakat. "Cardiovascular diseases and metabolic abnormalities associated with obesity: What is the role of inflammatory responses? A systematic review", Microvascular Research, 2020 | <1%        |
Malgorzata Rusak, Urszula Radzikowska, Barbara Glowinska-Olszewska, Elzbieta Dobrenko et al. "Endothelial progenitor cell levels in juvenile idiopathic arthritis patients; effects of anti-inflammatory therapies", Pediatric Rheumatology, 2015
Carotid intima-media thickness, hypertension, and dyslipidemia in obese adolescents

GRADEMARK REPORT

FINAL GRADE /100

GENERAL COMMENTS
Instructor