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Aim and Scope

World Nutrition Journal (abbreviated: W Nutr J) is an international, English language, peer-reviewed, and open access journal upholding recent evidence related to nutrition sciences. The journal accepts manuscripts in terms of original paper, case report, editorial, and letter to editor.

About

World Nutrition Journal was founded in 2016 as the official journal of Indonesian Nutrition Association. It aims to publish high quality articles in the field of community, clinical, and critical care aspects of nutrition sciences

Peer Review Process

All manuscripts submitted will be screened by an editor whether they have the requirements and accordingly to author instructions. Then, the editor will transfer them to Editor-in-chief. Editor-in-chief will choose peer-reviewer for the manuscripts, according to their field of expertise, with help from associate editors and editorial board members. Peer-review process should be based on Committee on Publication Ethics (COPE) standards. This journal uses double-blind review. After the peer review process and the manuscripts are approved, they will be sent back to Editor-in-chief. Afterwards, Editor-in-chief will send the approved manuscripts back to the editor for final editing, layout editing, and proofreading. Finally, the approved and edited manuscripts will be published.

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EDITORIAL

The Journal: Print or Electronic

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The World Nutrition Journal was conceived on the premise of academic and clinical education for healthcare providers caring for patients that require nutritional support.[1] The journal followed the open access (OA) methodology, allowing free access everywhere in the World. The main question that some asked was "why publish this journal electronically and not printed?"

Most of us are aware that one of the most important hallmarks of academic achievement in medicine and other areas is publication of scholarly-written articles. When discussing publishing a manuscript, the primary question is whether the target journal should be electronic or printed version. The many advantages of having electronic publications have created a series of websites, journals, webcasts that are useful for practitioners.[2]

In times of technological evolution, new technologies often imitate older entities that are not necessarily related; for example, early photography often imitated painting. Once individuals realized the capabilities of the new medium, photography developed as a distinct art form. Similarly, in the library world, older practices are often applied to the new medium of electronic information. Just as electronic journals (e-journals), have matured and become integral to library collections, so have journal-use studies progressed from those examining barriers to electronic journals' acceptance and desiderata for their design, to studies measuring use counts, to studies examining what the widespread adoption of electronic journals portend both academically and economically. Libraries early recognized that electronic journal design was key to their acceptance and engaged in numerous studies to determine effective design elements.

With so much of our daily communication now conducted online, there are some who feel it is time that scientific journals go the same route, replacing print with pixels. At the opposite pole are those who believe that print still rules when it comes to serious publications. The arguments favouring each are often framed in stark absolutes, with e-journals dismissed as lacking permanence and credibility and print journals scorned as the vestiges of an obsolescent technology. In truth, the

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two forms are complementary, each bringing unique assets to the table.

Print, of course, has served us well since Gutenberg invented movable type over 500 years ago. Many of the first books printed in volume were, in fact, scientific texts, the precursors of today's scientific journals. Virtually every branch of science now publishes scholarly journal promoting news of the latest developments in its field. In that capacity, the printed journal serves four key functions: disseminating information, ensuring the credibility of its content, establishing a permanent archive for scientific research, and offering its authors professional recognition.

Those who support online publishing emphasize several distinct advantages that it offers over print publishing. Some scholars, for instance, argue that electronic publication is more likely to facilitate communication within scholarly communities because of the speed with which it can be written, reviewed and edited, its ready accessibility, and the ease and economy of its distribution. They also point to the democratizing influence of the medium, which would allow greater numbers of authors to publish their work than is possible with print journals.

Print journals are limited in content and frequency by the overriding constrains of time, space, and rigorous adherence to standards of quality. Electronic publishing, on the other hand, free of these constraints, can broadcast research findings quicker and in larger quantities[3], to have this freedom allows authors to express themselves in a non-limited manner.

Lack of quality control, in fact, proves to be the most serious charge level against e-journals. Print journals, require stringent peer-review to ensure an article's accuracy before publication.[4] Applying the same standard to e-journals would necessarily lengthen the editorial process, undercutting the speed advantage promised by e-publishing. This, they fear, might encourage some publishers to shortcut review in favour of speed. Indeed, most scholars today go about their daily rounds without giving a thought to electronic publication.

In the authors' opinion, however, electronic publishing serves an important need in disseminating scientific and scholarly information quickly and easily, but not at the expense of print. It is not a killer technology, but rather an evolutionary development that adds yet another dimensions to the various ways that we as a society share knowledge. We applaud the efforts of the World Nutrition Journal to have a free-of-charge open-access medical periodical specifically dealing with nutrition that can easily be accessible everywhere in the World. Some of us are concerned about situations in which internet access is limited or non-existent. Where will clinicians get their answers from in those situations?

Open Access

References

1. Bardosono S. The Importance of Nutrition Journal Publication. World. Nutr. Journal. 2017 Sep 6;1(1).
2. Varon J, Marik PE: Critical care resources on the internet. A clinician's guide to the information superhighway. J Crit Illness 1997;12(8)525–7.
3. Fromm RE, Varon J, Sternbach GL: Emergency medicine cyberspace. J Emerg Med 1996;14(1):91–2.
4. Wenker O, Varon J: Peer review on the internet. The Internet Journal of Anesthesiology 1997; http://www.ispub.com/journals/IJA/Vol1N2/peer.htm. Accessed November 1, 2017.

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CASE REPORT

Enteral Nutrition Support for Mechanically Ventilated, Morbidly Obese Patient with Abdominal Compartment Syndrome (ACS): A Case Report from a Medical Intensive Care Unit (ICU)

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Abstract

Abdominal compartment syndrome (ACS) is said to occur when intra-abdominal pressure (IAP) is greater than 20 mmHg in association with new organ failure. This pressure can decrease blood flow to nerve and muscle cells, leading to ischemia and organ dysfunction. Challenges in providing enteral nutrition for abdominal compartment syndrome (ACS) patients include the increased risk for developing gastrointestinal symptoms such as diarrhea, constipation and distention. There are limited reports available on the nutritional management of ACS patients in the ICU, especially those with morbid obesity condition, to guide dietitians in providing nutritional support for these patients. Here, we report the enteral nutrition management of a mechanically ventilated, morbidly obese patient with ACS in a critical care setting by adopting post-pyloric feeding, using pro-kinetic agents and implementing PO_2/FiO_2 ratio calculation for prescription of most suitable enteral formula.

Keywords Critical Care Nutrition; Nutrition Support; Intensive Care Unit; Enteral Nutrition; Abdominal Compartment Syndrome

Introduction

Intra-abdominal hypertension (IAH) is defined by the World Society on Abdominal Compartment Syndrome (WSACS) as a persistent intra-abdominal pressure greater than 12 mmHg. In addition, abdominal compartment syndrome (ACS) is said to occur when intra-abdominal pressure (IAP) is greater than 20 mmHg in association with new organ failure.[1] The pressure can decrease blood flow to nerve and muscle cells, leading to ischemia and organ dysfunction. Studies have been suggested that the incidence of ACS and IAH, when associated with septic shock, can be as high as 30% to 85% respectively.[2] Both ACS and IAH are growingly recognized complications impacting 30–50% of intensive care unit (ICU) patients and have mortality rates of 70–80% if left untreated.[3-5]

Some of the most common early clinical manifestations of IAH and ACS in critically ill

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patients including abdominal distention, oliguria, elevated peak respiratory pressures and difficulty in ventilating. Because of its simplicity and low cost, bladder pressure measurement has been considered as the gold standard to measure IAP.[2,6–7]

Studies have been shown that IAH can affect the central nervous system by raising intra-cranial pressure and also decreasing renal function. Malbrain et al.[3] reported that IAH could independently cause acute kidney injury (AKI). The effect of IAH on gastrointestinal organs leads to decreased gut perfusion. This change can lead to bowel ischemia and edema to infectious risk associated with mucosal hyperpermeability.[8]

The provision of nutrition care to the mechanically ventilated patients in the ICU, most commonly through enteral nutrition, is known to present with numerous challenges due to multidisciplinary and heterogeneous medical condition, severity of illness and specific individual needs.[9] Furthermore, the presence of obesity in mechanically ventilated patients increases the complexity of care. The more severe the obesity, the more demanding the routine of nursing care and diagnostic or therapeutic interventions can be due to patients' physical condition. Similarly, providing enteral nutrition to the obese-mechanically ventilated patients can also be complicated as these patients are prone to develop stress-induced hyperglycemia.[10] Obese-critically ill patients also have altered metabolic processes when compared to their non-obese counterpart.[11–12]

In terms of providing enteral nutrition for IAH/ACS patients, the challenges including the increase risk for developing gastrointestinal symptoms such as diarrhea, constipation and distention. The use of opiate sedation may contribute to decrease gastric motility.[13] Additionally, in critically ill patients, there is an increased risk of developing serious metabolic complications due over feeding including hypercapnia, hyperglycemia, azotemia, hepatic steatosis and metabolic acidosis among others.[14-15]

There are limited reports available on the nutritional management of ACS patients in the ICU especially those with morbid obesity condition to guide dietitians in providing nutritional support for these patients. Here, we report the enteral nutrition management of a mechanically ventilated, morbidly obese patient with ACS in a critical care setting by adopting post-pyloric feeding, using pro-kinetic agents and implementing PO_2/FiO_2 ratio calculation for prescription of most suitable enteral formula.

Client History

A 53-year-old African American female with severe chronic obstructive pulmonary disease (COPD) presented to the Emergency Department with progressive symptoms of severe shortness of breath and swelling of lower extremities. She had a known past medical history of severe oxygen dependent COPD. In the last 12 months, she had multiple hospitalizations for COPD exacerbations.

Upon presentation, she was afebrile with elevated white blood cell count. Chest x-ray showed bilateral atelectasis while her ECG revealed sinus tachycardia with no acute ischemic changes. She was then admitted with initial diagnosis of acute respiratory failure and subsequently transferred to the medical intensive care unit (MICU) for ventilator support. In MICU, she was intubated, sedated and received fluid resuscitation. During the next 24 hours, she had periods of low urine output and subsequently developed non-oliguric acute kidney injury (AKI) with worsening metabolic acidosis. Noticeable increase in bladder pressure and abdominal distension revealed a diagnosis of abdominal compartment syndrome. In the meantime, progressive hypercapnea and auto-PEEP had led to the decision to chemically paralyze her with the neuromuscular blocking agent (NMBA), *cisatracurium*. She was then maintained on a continuous infusion of *cisatracurium*. Shortly following paralysis, bladder pressure decreased and she had urine output of more than 300 ml. During the next few days, her creatinine level returned to normal. She continued to receive other non-surgical therapy to control IAP by gastric decompression and soapsuds enema.

The patient was kept nothing by mouth (NPO), following sedation and intubation in the ICU. Bedside placement of a naso-jejunal feeding tube was done within 72 hours after admission using electromagnetically guided placement device

(EMPD) and dietitian was consulted on Day 3 for enteral nutrition initiation.

Nutrition Care Process:

Nutrition Assessment

Patient was morbidly obese (BMI of 40.6 kg/m^2) with admission weight of 100.8 kg. Her ideal body weight (IBW) for her height of 157.5 cm was 50 kg. She was at 202% of her IBW and 110% of her usual body weight (UBW) during presentation at the hospital with no reported weight loss prior to admission. This was supported by her last documented weight available on hospital electronic record (91 kg) indicating 10% weight gain in 10 months.

Information on food/nutrition-related history was obtained mainly from the nutrition screening form upon admission and the medical record. Prior to admission, the patient was not reported to follow a weight loss diet or any other therapeutic diet for her morbid obesity condition and other nutrition-related clinical diagnoses. The patient was kept NPO following sedation and intubation in the ICU.

Biochemical assessment revealed elevated levels of blood urea nitrogen (BUN), serum creatinine and phosphorus related to AKI resulted from ACS. Other electrolytes and CO_2 level were within normal limits (Table 1). In order to determine the patient's lung function, partial pressure of oxygen/fraction of inspired oxygen (PO_2/FiO_2) ratio was calculated (PO_2, 93.6 mmHg; FiO_2, 40% from arterial blood gas analysis and ventilator setting respectively). Calculation of PO_2/FiO_2 ratio (<300 mmHg) revealed a status of acute lung injury (ALI).

Table 1 Biochemical data

Parameter	Reference range	Day 3	Day 6	Day 10	Day 20	Day 23
Sodium (mmol/L)	135–145	137	152	138	141	139
Potassium (mmol/L)	3.5–5.2	5.2	5.6	5.1	4.6	3.7
Chloride (mmol/L)	98–109	98	108	95	104	100
Carbon dioxide, CO_2 (mmol/L)	23–34	27	37	39	29	30
Blood urea nitrogen (mg/dL)	8–20	40	41	32	NA	14
Creatinine (mg/dL)	0.70–1.20	3.31	0.85	0.54	0.31	0.29
Magnesium (mEq/L)	1.3–1.9	NA	2.1	2.4	3.0	1.5
Phosphorus (mg/dL)	2.4–4.5	6.8	2.8	3.2	2.3	NA
Albumin (g/dL)	3.5–5.0	3.6	3.3	3.5	NA	NA
White blood cell (Thou/cu mm)	4.0–11.0	17.8	13.8	20.7	11.9	6.7
Glucose (mg/dL)	70–200	148	224	149	122	133

NA= Not Available

Energy needs were initially estimated based on Penn 2003b[16] formula at 1681 kcal per day using admission weight. Protein needs were calculated at 110 g per day (2.0 g/kg IBW/day) based on ASPEN recommendation for critically ill adults with BMI between 30–40 kg/m^2.[17] Fluid needs were not specified and were based on physician order due to

the critical condition of patient requiring fluid resuscitation.

Nutrition Diagnosis

Patient had increased energy and protein needs from her critical illness. However, enteral nutrition support was not initiated within 24–48 hours due to hemodynamic instability. Patient was at risk of malnutrition in acute setting with delayed initiation of feeding. The nutrition diagnosis during initial assessment was "Inadequate protein and energy intake related to medical condition, intubation and altered gastrointestinal function as evidenced by patient on ventilator, estimated nutrient needs not met, current NPO status and unable to initiate feedings to rule out ileus".

Nutrition Intervention and Prescription

Nasojejunal feeding of Oxepa®,[18] a concentrated enteral formulation with anti-inflammatory lipid profile and antioxidants was recommended to be initiated at 20 mL/hour continuously over 24 hours with slow feeding rate advancement as tolerated by the patient to the goal rate of 40 mL/hour. Healthy Shot®, a liquid high protein supplement was also recommended to be given twice daily via feeding tube in order to meet the patient's high protein needs providing in total of 1640 kcal and 108 g protein per day. The use of additional modular protein supplements to ensure adequate delivery of protein is a common practice.[18] In addition, Healthy Shot® was the only liquid modular protein supplement available at the facility for enteral feeding use, thus, it was chosen to be given to patient in order to meet her high protein needs (Table 2).

Nutrition Monitoring/Evaluation and Outcome

Parameters monitored for this patient included electrolyte profile, enteral nutrition tolerance, enteral nutrition intake, gastrointestinal profile, glucose/endocrine profile, renal profile, protein profile and CO_2 levels (Table 1). Upon follow up, elevated CO_2 and glucose levels were seen (Day 6) indicating possible overfeeding. Permissive hypocaloric feeding was then introduced, revising the energy requirement at 1109–1411 kcal (11–14 kcal/kg actual body weight per day) based on obese, critically ill adults guidelines[18] while maintaining the same high protein needs. Permissive hypocaloric feeding is defined as intentional delivery of less non-protein nutrients than what is normally required daily. The concept of permissive hypocaloric feeding is based on the rationale that higher nutrient intake is detrimental from a metabolic and functional perspective. Studies with obese patients have demonstrated that a hypocaloric feeding regimen can promote nitrogen equilibrium and minize negative nitrogen balance without causing weight loss.[19]

The goal rate for Oxepa® was modified to 35 mL/hr with Healthy Shot® order of twice daily remained as previously prescribed. To optimize bowel management, pro-motility agents, Reglan and erythromycin were also recommended. On Day 21, patient was transferred to ICU step down unit and was discharged on Day 32 to a long term acute care facility with a feeding tube regimen using Glucerna 1.2®, a calorically dense diabetes-specific formula planned for better carbohydrate intake control in view of the patient having a chronic COPD. Energy needs for discharge plan was calculated using the Mifflin-St. Jeor formula (x1.2 factor) with protein needs of 2.0 g/kg IBW per day (1850 kcal, 100 g protein per day). The formula is commonly used in clinical practice and it is the most reliable, predicting Resting Metabolic Rate (RMR) within 10% of measured in non-obese and obese individuals than any other equation and it also had the narrowest error range.[20] The recommended goal rate was 65 mL/hr providing 1880 kcal, 94 g protein and 179 g carbohydrate. Table 3 summarizes enteral nutrition prescriptions for this patient throughout her hospitalization.

Table 2 Nutrition facts for nutrition intervention prescriptions

Nutrition facts	Oxepa® (1000 mL)	Healthy Shot® (75 mL)	Glucerna 1.2® (237 mL)
Calories (kcal)	1500	100	285
Protein (g)	62.7	24	14.2
Total carbohydrate (g)	105.3	1	27.1
Total fat (g)	22.2	0	14.2
Water (mL)	186	NA	192
Vitamin A (IU)	2840	NA	1840
Beta-carotene (mg)	1.2	NA	0.63
Vitamin D (IU)	100	NA	82
Vitamin E (IU)	75	NA	9.2
Vitamin K (mcg)	20	NA	24
Vitamin C (mg)	205	22.5	62
Folic acid (mcg)	200	NA	76
Thiamin (mg)	0.75	NA	0.29
Riboflavin (mg)	0.85	NA	0.33
Vitamin B6 (mg)	1.0	NA	0.38
Vitamin B12 (mcg)	3.0	NA	1.2
Niacin (mg)	10	NA	3.8
Choline (mg)	150	NA	105
Biotin (mcg)	150	NA	57
Panthothenic acid (mg)	5.0	NA	1.9
Sodium (mg)	310	80	265
Potassium (mg)	465	NA	480
Chloride (mg)	400	NA	305
Calcium (mg)	250	78	190
Phosphorus (mg)	250	NA	190
Magnesium (mg)	100	NA	76
Iodine (mcg)	38	NA	29
Manganese (mg)	1.3	NA	0.38
Copper (mg)	0.50	NA	0.38
Zinc (mg)	5.7	NA	2.9
Iron (mg)	4.5	0.7	3.5
Selenium (mcg)	18	NA	14
Chromium (mcg)	30	NA	38
Molybdenum (mcg)	38	NA	19
L-carnitine (mg)	43	NA	NA
Taurine (mg)	75	NA	NA

NA= Not Available

Table 3 Enteral nutrition prescriptions

Hospitalization Day	Energy Needs (kcal/day)	Protein Needs (g/day)	Enteral Formula Prescription		
			Oxepa®	**Healthy Shot®**	**Glucerna 1.2®**
Day 1 (MICU admission)			Feeding not yet initiated		
Day 3 (Initial RD consultation)	1681 (Penn 2003b)[16]	110 (2.0 g/kg IBW/day)[17]	Start rate: 20 mL/hour Goal rate: 40 mL/hour	75 mL bd	-
			Energy: 1460 kcal/day Protein: 101 g/day		
Day 6 (Day 5 post EN initiation)	1109-1411 (11-14 kcal/kg ABW per day)[17]	110 (2.0 g/kg IBW/day) [17]	35 mL/hour	75 mL bd	-
			Energy: 1460 kcal/day Protein: 101 g/day		
Day 21 (Transferred to ICU step down unit)	1109-1411 (11-14 kcal/kg ABW per day)[17]	110 (2.0 g/kg IBW/day) [17]	35 mL/hour	75 mL bd	-
			Energy: 1460 kcal/day Protein: 101 g/day		
Day 32 (Discharged plan)	1850 (Mifflin St. Jeor)[20]	100 (2.0 g/kg IBW/day) [17]	-	-	65 mL/hour
					Energy: 1880 kcal/day Protein: 94 g/day

MICU = Medical Intensive Care Unit
RD = Registered Dietitian
bd = twice a day
EN = Enteral Nutrition

Discussion

ACS commonly occurs in critically ill patients. Among other gastrointestinal effects from this syndrome, gut hypo-perfusion that may lead to bowel ischemia together with decreased gastric motility as part of IAH pathophysiology and the impact from opiate sedation are of major concerns in providing a successful enteral feeding. In this report, there were three major nutrition concerns. Firstly, in a patient with IAH, enteral feeding itself can aggravate bowel ischemia or worsen IAH due to fermentation and bowel distention and gastrointestinal symptoms.[21] Secondly, possibility of feeding intolerance secondary to decreased gastric motility from opiate sedation.[13] Thirdly, increased risk of developing serious metabolic complications if over feeding occurs.[14,15] Overall, our patient was able to tolerate the hypo-caloric, high protein enteral feeding regimen despite several feeding interruptions due to medical condition and procedures.

In conclusion, provision of enteral nutrition support for ACS patients requires careful attention and aggressive measures such as adopting post-pyloric feeding to maximize the delivery of enteral feeding. Hill et al.[8] previously reported a low percentage of possibility for exclusive enteral nutrition support via nasogastric among these patients, thus, post-pyloric feeding should be considered. It is also beneficial to use pro-kinetic agents to optimize bowel management in managing ACS cases. Furthermore, in mechanically ventilated patients, PO_2/FiO_2 ratio calculation is useful for possible prescription of formula suitable for lung impairment.

Conflict of Interest

The authors of this paper declare there is no conflict of interest regarding this research.

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References

1. Malbrain ML, Cheatham ML, Kirkpatrick A, Sugrue M, Parr M, Waele, J. De , et al. Results from the international conference experts on intra-abdominal hypertension and abdominal compartment syndrome. I. Definitions. Intensive Care Med 2006;32:1722-32. [Google Scholar]
2. Daugherty EL, Liang H, Taichman D, Hansen-Flaschen J, Fuchs BD. Abdominal compartment syndrome is common in medical intensive care unit patients receiving large-volume resuscitation. J Intensive Care Med 2007;22:294-9. [Google Scholar]
3. Malbrain ML, Chiumello D, Pelosi P, Bihari D, Innes R, et al. Incidence and prognosis of intraabdominal hypertension in a mixed population of critically ill patients: a multiple-center epidemiology study. Crit Care Med 2005;33:315-322. [Google Scholar]
4. Sugrue M. Abdominal compartment syndrome. Curr Opin Crit Care 2005;11:333-8. [Google Scholar]
5. Theodossis SP, Athanasios DM, Ioannis P, Isaak K, Nicki P. Abdominal compartment syndrome-Intraabdominal hypertension: Defining, diagnosing, and managing. J Emerg Trauma Shock 2011;4(2):279-91. [Google Scholar]
6. Cheatham ML, Malbrain ML, Kirkpatrick A, Surgue M, Parr M, Waele, J. De , et al. Results from the International Conference Experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome. II. Recommendations. Intensive Care Med 2007;33:951-62. [Google Scholar]
7. Malbrain M. Different techniques to measure intra-abdominal pressure (IAP): Time for a critical appraisal. Intensive Care Med 2004;30:357-71. [Google Scholar]
8. Hill LT, Miller M. The effect of intra-abdominal hypertension on gastrointestinal function. Southern African Journal of Critical Care 2011;27(1):12-8. [Google Scholar]
9. Yip KF, Rai V, Wong KK. Evaluation of delivery of enteral nutrition in mechanically ventilated Malaysian ICU patients. BMC anesthesiology 2014;14(1):127. [Google Scholar]
10. Port AM, Apovian C. Metabolic support of the obese intensive care unit patient: a current perspective. Curr Opin Clin Nutr Metab Care 2010;13(2):184-191. [Google Scholar]
11. Secombe P, Harley S, Chapman M, Aromataris E. Feeding the critically ill obese patient: a systematic review protocol. JBI Database System Rev Implement Rep 2015;13(10):95-109. [Google Scholar]
12. Jeevanadam M, Young DH, Schiller WR. Obesity and the metabolic response to severe multiple trauma in man. J Clin Invest 1991;87(1):262-269. [Google Scholar]
13. Nguyen NQ, Chapman MJ, Frase RJ, Bryant LK, Burgstad C, Ching K, et al. The effects of sedation on gastric emptying and intra-gastric meal distribution in critical illness. Intensive Care Med 2008;34:454-460. [Google Scholar]
14. Reid C. Frequency of under- and overfeeding in mechanically ventilated ICU patients: causes and possible consequences. J Hum Nutr Dietet 2006;19:13-22. [Google Scholar]

15. Klein CJ, Stanek GS, 3rd WCE. Overfeeding macronutrients to critically ill adults: metabolic complications. J Am Diet Assoc 1998;98(7):795-806. [Google Scholar]
16. Frankenfield D, Smith JS, Cooney RN. Validation of 2 approaches to predicting resting metabolic rate in critically ill patients. JPEN 2004;28:259-264. [Google Scholar]
17. McClave SA, Taylor BE, Martindale RG, Warren MM, Johnson DR, Braunschweig C, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N. JPEN 2016;40(2):159-211. [Google Scholar]
18. McClave SA, Martindale RG, Vanek VW, McCarthy M, Roberts P, Taylor B, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of critical care medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N. JPEN J Parenteral Enteral Nutr 2009;33(3):277-316. [Google Scholar]
19. Malone AM. Permissive underfeeding: its appropriateness in patients with obesity, patients on parenteral nutrition, and non-obese patients receiving enteral nutrition. Curr Gastroenterol Rep 2007;9(4):317-322. [Google Scholar]
20. Frankenfield D, Roth-Yousey L, Compher C. Comparison of predictive equations for resting metablic rate in healthy nonobese and obese adults: a systematic review. J Am Diet Assoc 2005;105(5):775-789. [Google Scholar]
21. Hill LT, Hill B, Miller M, Michell WL. The effect of intra-abdominal hypertension on gastro-intestinal fucntion. Southern African J Crit Care 2011;27(1):12-19. [Google Scholar]

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ORIGINAL PAPER

IGF-1 Levels Among Adolescent Girls Living in Jakarta and Its Relation to Nutritional Status

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Abstract

Introduction: Insulin-like growth factor (IGF)-1 is one of the hormones that plays a role in the growth of adolescent girls. Its level will rise at puberty and begin to decline at the end of puberty. High IGF-1 levels in adult is associated with the incidence of breast cancer. This study aims to know the level of IGF-1 and investigates its relationship with dietary intake, nutritional status, and physical activity of adolescent girls aged 13–15 in Jakarta.

Methods: This cross-sectional study used secondary data from a previous study (titled "Determinant Factor Levels of Estradiol, IGF-1, and Early Menarche in Adolescent Girls Aged 13-15 in Jakarta: Nutritional Epidemiology Study Related to Breast Cancer Risk Factors") and primary data from stored blood serum to measure IGF-1 levels by colorimetric method. The secondary data such as dietary intake, anthropometric data, and physical activities were obtained from 178 subjects with a total population sampling method.

Results: There was a positive correlation between IGF-1 levels and carbohydrate intake (p=0.041, r=0.153) and a negative correlation between IGF-1 levels and fat intake (p=0.042, r=-0.152). No correlation between IGF-1 and body mass index was found, but there was a tendency that IGF-1 values would increase in overweight and decrease in obesity. IGF-1 levels have nonlinear pattern by carbohydrates intake, fat intake and nutritional status.

Conclusion: The adolescent girls should maintain their nutritional status by maintaining diet, choosing the right and balanced foods, as well as increasing physical activities.

Keywords adolescent girls, dietary intake, IGF-1 , nutritional status

Introduction

Adolescence is a transition period when a child grows and develops into adult. There is a growth spurt in adolescent girls beginning on average at 9–10 years old.[1] During growth spurt, these will occur: fast and intense increases in height, changes in body composition which causes weight gain, reproductive organ and secondary sexual characteristic development, and changes in the circulatory and respiratory system.[2] Dramatically changes in the body of adolescent girls are the

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decrease in lean body mass and the increase in body fat. The body fat of girls increases by two-fold before the end of puberty.[2-4] The end of puberty for girls is marked by menarche, and the average age of menarche in Indonesia are 13 years old.[5]

Adolescent growth is influenced by endogenous factors such as genetic and hormonal or endocrine body as well as exogenous factors such as nutrition, physical activity, and environment. When these factors are disturbed, it could affect the adolescent's health, reflected in the nutritional status as measured by body mass index (BMI). Excess needs of energy intake in adolescent girls take a result in overweight and obesity, which could continue to adults. In obesity, the risk of insulin resistance increases and that can develop into diabetes or cardiovascular disease, and the risk of cancer would also increase.[6-7]

Insulin-like growth factor-1 (IGF-1) or somatomedin is the hormone which its synthesis is stimulated by growth hormone (GH). IGF-1 is the mediator of anabolic and mitogenic effects of growth hormone in supporting adolescent growth.[8-9] Its levels will rise when growth spurt occurs and begin to decline at the end of puberty.[10] Several studies showed that high IGF-1 levels in adults related to an increasing risk of several cancers, such as breast, colon, and prostate cancer.[11] Meta-analysis study in breast cancer showed that higher IGF-1 level related with higher risk of premenopausal breast cancer.[12] The level of IGF-1 is affected by several factors associated with lifestyle such as diet intake, anthropometry, and physical activity.[13-15] In Indonesia, there is no data on IGF-1 levels in adolescent girls aged 13–15 . Therefore, this study was conducted to investigate the relationship between IGF-1 and nutritional status in adolescent girls as a prevention of the increasing risk of cancer when the teenagers become adults.

Methods:

Study Design

Participants in this cross-sectional study were adolescent girls from previous study titled "Determinant Factor Levels of Estradiol, IGF-1, and Early Menarche in Adolescent Girls Aged 13–15 in Jakarta: Nutritional Epidemiology Study Related to Breast Cancer Risk Factors." In that previous study, the subjects had been recruited from January 2014 to January 2015. In this study, we used secondary data (such as dietary intake, anthropometry, and physical activities status) and primary data from the previous study stored blood serum. The eligible criteria were: subjects had no chronic illnesses, their parents signed the informed consent of prior research, subjects already had menarche and were not in steroid medication.

Study Design

The study was done in the selected eight Junior High Schools representing the five municipalities in Jakarta. This study started after obtaining permission from Medical Ethics Committee, Faculty of Medicine University of Indonesia

Data Collection

The dietary intakes (total of energy, carbohydrate, protein, and fat) were collected using semi-quantitative food frequency questionnaire (FFQ) by experienced nutritionists. Dietary intake data were then analyzed using Nutrisurvey 2007. The total of energy and macronutrient intake were categorized as minimal (<70%), low (70–99.9%), normal (100–129.9%), and high (≥130%), based on the Indonesian recommended daily allowance (RDA). Category of macronutrient intake also was categorized based on proportion of total macronutrient to energy. Height and weight were measured in accordance to the standard protocol by trained personnel. The results of measurements of weight and height were then used to calculate body mass index (BMI) using the formula weight (in kg) divided by height (in meters) squared. BMI values were adjusted to BMI-for-age CDC 2000 chart for girl aged 2–20 using Children's BMI Tool for School to get BMI-for-age percentile. The subjects' aged 13–14 completed Physical Activities Questionnaire-Children (PAQ-C) and the subjects' physical activity level (PAL). IGF-1 levels were measured from the stored blood serum by colorimetric method in Dharmais Cancer Hospital laboratory, Jakarta.

All data were analyzed using Statistical Package for Social Science (SPSS) version 20.0. Normality of data was analyzed using Kolmogorov Smirnov test. Normally distributed data were presented in mean±SD while not-normally distributed data were presented in median (minimum-maximum). The correlation between percentile values and diet intake with IGF-1 values was analyzed using Pearson or Spearman rank test. The difference of IGF-1 values between groups of nutritional status and dietary intake (based on proportion to energy) were analyzed using unpaired t-test or one-way ANOVA. The $p<0.05$ was considered as statistical significance.

Results

The analyses were based on 178 adolescent girls with complete data on IGF-1 values. The characteristic data including anthropometric (weight, height, and BMI-for-age percentile), nutritional status, dietary intake, physical activity, and serum IGF-1 is presented in Table 1.

Table 1 Characteristic of subjects based on anthropometric, nutritional Status, dietary intake, and physical activity (n=178)

Characteristic	n (%)	Mean±SD/median (min-max)
Energy, kcal		1579.5 (702.9–2962.8)
Adequacy of energy intake		
Minimal (<70% RDA)	70 (39.3)	
Low (70–99.9% RDA)	81 (45.5)	
Moderate (100–129.9% RDA)	23 (12.9)	
High (≥130% RDA)	4 (2.2)	
Total carbohydrate, g/day		211.8 (74.3–432.9)
Adequacy of carbohydrate intake		
Minimal (<70% RDA)	77 (43.3)	
Low (70–99.9% RDA)	69 (38.8)	
Moderate (100–129.9% RDA)	26 (14.6)	
High (≥130% RDA)	6 (3.4)	
Total carbohydrate, % of energy		54.9±6.8
Proportion of total carbohydrate to energy		
Low (<50% energy)		
Moderate (50–60% energy)	39 (21.9)	
High (>60% energy)	96 (53.9)	
	43 (24.2)	
Total protein, g/day		45.5 (13.8–128.3)
Adequacy of protein intake		
Minimal (<70% RDA)	100 (56.2)	
Low (70–99.9% RDA)	55 (30.9)	
Moderate (100–129.9% RDA)	14 (7.9)	
High (≥130% RDA)	9 (5.1)	
Total protein, % of energy		11.8 (7.1–37.5)
Proportion of total protein to energy		
Low (<10% energy)	31 (17.4)	
Moderate (10–20% energy)	146 (82.0)	
High (>20% energy)	1 (0.6)	
Total fat, g/day		57.1 (14–120.8)
Adequacy of fat intake		
Minimal (<70% RDA)	57 (32)	
Low (70–99.9% RDA)	73 (41)	
Moderate (100–129.9% RDA)	40 (22.5)	
High (≥130% RDA)	8 (4.5)	

Table 1 Characteristic of subjects based on anthropometric, nutritional Status, dietary intake, and physical activity (n=178) (Continued)

Characteristic	n (%)	Mean±SD/median (min-max)
Total fat, % energy		32.7±6.7
Proportion of total fat to energy		
Low (<20% energy)	37 (3.9)	
Moderate (20–30% energy)	47 (26.4)	
High (>30% energy)	124 (69.7)	
Weight, kg		45.9 (31.0–80.2)
Height, cm		152.6±6.2
BMI-for-age percentile		58.5 (0–98.6)
Nutritional status		
Underweight	6 (3.4)	
Normal	133 (74.7)	
Overweight	28 (15.7)	
Obese	11 (6.2)	
Physical activities score		1.85±0.34
Physical activities		
Low	165 (92.7)	
Moderate	13 (7.3)	
IGF-1, ng/mL		470.5±147.2

Among these subjects, 84.8% had energy intake less than the RDA for adolescent girls aged 13–15 . While 53.9% of the subjects had moderate proportion of carbohydrates intake to total energy, 82% of the subjects had moderate proportion of protein intake to total energy, and 69.7% of the subjects had high proportion of fat intake to total energy. There were only 6 subjects (3.4%) underweight, and on the other hand 39 subjects (21.9%) were overweight/obese. Almost all subjects had low physical activity level, i.e. 165 subjects (92.7%), while the remaining 13 subjects (7.3%) had moderate physical activities.

The correlations between IGF-1 with nutritional status and macronutrient intake are shown in Table 2.

Table 2 Correlations between IGF-1 levels and BMI-for-age percentile and dietary intake (n=178)

Variable	IGF-1 Levels (ng/mL)	
	p	r
BMI-for-age percentile	0.754‡	-0.024
Dietary intake		
Energy, kcal	0.758‡	0.023
Carbohydrate, % of energy	**0.041***	**0.153**
Carbohydrate, g/day	0.242‡	0.088
Protein, % of energy	0.237‡	-0.089
Protein, g/day	0.697‡	-0.029
Fat, % of energy	**0.042***	**-0.152**
Fat, g/day	0.229‡	-0.091

* Pearson rank test; ‡ Spearman rank test

There is no correlation between BMI-for-age percentile and IGF-1. Of the diet variables, carbohydrate is associated to IGF-1 (p=0.041, r=0.153), whereas fat is inversely associated to IGF-1 (p=0.042, r=-0.152). We observed that there was no statistically significant difference in IGF-1 between nutritional status and diet intake groups. However, there was a trend that IGF-1 would increase in overweight group and decrease in obese groups (Figure 1).

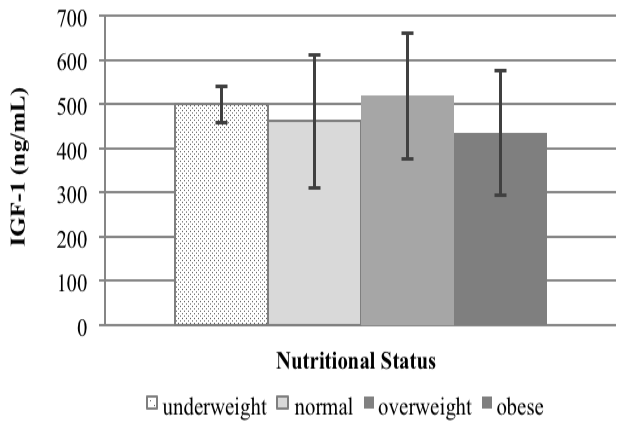

Figure 1 IGF-1 Difference between nutritional status groups

Also, there were smooth trends towards higher IGF-1 levels with increasing carbohydrate intakes and lower IGF-1 with increasing fat intake (Figure 2).

Discussion

This research was the first research conducted in Indonesia that measured the levels of IGF-1 in young girls accompanied by other comprehensive factors such as diet intake, anthropometry, and physical activity. The advantages of this study include the large number of subjects – nearly 200, the research conduct in eight schools among five areas in Jakarta, and the random selection. Sample collection was also carried out at the same time, i.e. in the morning, to prevent the diurnal variation of IGF-1 examination.[16] Subjects were also carried out on fairly strict inclusion criteria to minimize other variations of health conditions that could affected the subjects. Therefore, the results of this study could be generalized to the population of adolescent girls aged 13–15 in major cities in Indonesia. Meanwhile, the weakness of this study is it used cross-sectional design that could be threatening by the possibility of the recall bias when taking dietary intake and physical activity data.

We found that almost all of the subjects had low physical activity level. The sedentary lifestyle may become the risk factors for non-communicable diseases (NCDs) that starting from childhood and adolescence.

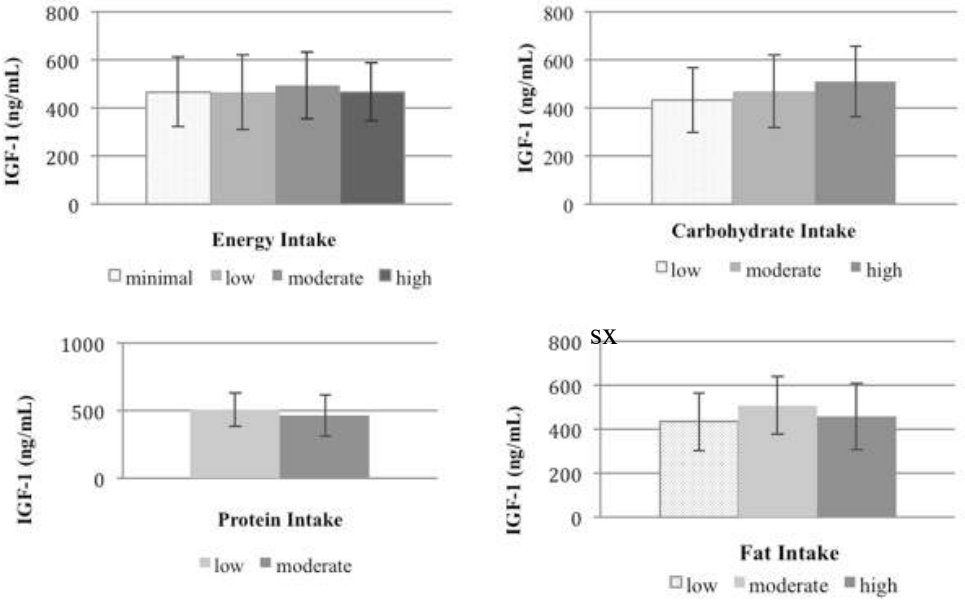

Figure 2 IGF-1 Difference between dietary intake group (n=178)

In spite of the sedentary lifestyle, unhealthy eating habits can be the cause of some degenerative diseases such as cardiovascular disease, metabolic syndrome and cancer. Furthermore, there is evidence that 90–95% of cancer is influenced by lifestyle factors and the environment. Focusing for cancer, especially breast cancer for the adolescent girls, it can be prevented with lifestyle modifications such as a good diet, maintaining a normal body weight, and increasing physical activities.[17] Thus, it is very important the teen years become the focus of attention of the government to initiate programs in the prevention of degenerative diseases, especially cancer in the future.

This study examined the relationship between IGF-1 and nutritional status and dietary intake in adolescent girls aged 13–15. We found that there was no relationship between IGF-1 and BMI-for-age percentile. This study is consistent with the study of 243 girls in grade 6 and 7, in which there is no relationship between the levels of IGF-1 with the body composition such as body mass index, thickness of skin folds, waist/hip, height, and weight.[18] Lukanova et al.[14] reported there was no significant difference in the levels of IGF-1 in each group based on BMI in 391 adult women. However, the levels of IGF-1 in each group described the nonlinear relationship, which means the levels of IGF-1 will reach the highest level at a certain IMT, and then it will decrease. After grouping based on the nutritional status according to BMI-for-age, there was no statistically significant difference in IGF-1 between nutritional status groups. However, the pattern of mean levels of IGF-1 in each group tended not to be linear. IGF-1 levels increased from normal to overweight, then decreased in obese.

The nonlinear relationship between IGF-1 and BMI can be explained by the interaction of the two major determining factors of the synthesis and bioavailability of IGF-1, namely growth hormone (GH) and insulin. GH is a major stimulus for the secretion of IGF-1 and the main carrier in the blood protein, IGFBP-3. In a condition like obesity, free fractions of IGF-1 increase because of the increased production by the liver and adipose tissue as well as the increase of insulin levels. The increase levels of insulin will also inhibit the synthesis of IGFBP-1 and IGFBP-2. Increased free fractions IGF-1 give negative feedback on GH.[14,19,20] Decreased GH secretion in obesity also can be caused due to increased levels of free fatty acids in blood. A rise of free fatty acids in blood in obesity happens due to the enlarged fat cells which secrete free fatty acids in the blood more and the decrease clearance of free fatty acid.[21,22] The decrease of GH secretion causes a decrease in total levels of IGF-1.

Excess body weight is estimated to be the cause of 20% of all cancer cases. In the last 25 years, the data showed that obesity is the cause of 20% of cancer deaths in women. A retrospective study showed an association between elevated BMI and the incidence of breast cancer in the premenopausal woman.[23] On the other hand, a systematic review and meta-regression analysis of case-control studies which included 3,609 cases and 7,137 controls has demonstrated that high concentrations of IGF-I were associated with an increased risk premenopausal breast cancer.[24] With the results from this study that IGF-1 levels increase in overweight adolescent, it can be a caution for adolescent girls to maintain their weight and nutritional status to avoid from increasing premenopausal breast cancer risk.

In this study, we also found a positive correlation between the levels of IGF-1 with the proportion of carbohydrate intake ($p=0.004$, $r=0.153$) and an inversed correlation with fat intake ($p=0.04$, $r=-0.152$). There was no correlation between the levels of IGF-1 with a proportion of total energy intake and protein intake. Cui et al.[25] reported a positive association between the proportion of carbohydrate intake with high levels of IGF-1 and a negative association between the proportion of fat intake with high levels of IGF-1. With substitution of 5% of the energy from carbohydrates for the equivalent amount of energy from fat or protein, IGF-1 levels increased by 2%. When substituting 1% of the energy from fat for the equivalent amount of energy – a 1% increase in the proportion of fat to total energy, IGF-1 levels decreased by 2.8%.

Changes in carbohydrate intake will provide an indirect effect on IGF-1 levels through changes in insulin secretion. The synthesis of IGF-1 in the liver is also regulated by insulin. Studies in animals showed that by blocking the action of insulin in the

liver, serum IGF-1 levels decreased. Increased intake of carbohydrates will increase the amount of insulin in the circulation. Increased insulin stimulates GH secretion and has effects on IGF-1 gene transcription so that the levels of IGF-1 will rise.[26] Inversed association between IGF-1 and fat intake can be explained due to increased fat intake can rise free fatty acids levels in the blood. The increase in free fatty acids will result in inhibition GH secretion.[22] Inhibited GH secretion causes decreased secretion of IGF-1.

Several studies suggest that higher concentrations of IGF-I are associated with a reduced risk of degenerative diseases like osteoporosis, diabetes, and possibly heart disease; otherwise, they are also associated with increased risk of cancers including breast, prostate, and colon cancer. Most of the IGF-related cancers are associated with dietary patterns, so the role of diet in regulating the IGF system has attracted interest.[11] Circulating concentrations of IGF-I can be affected by dietary intake through some potential mechanisms include the inhibition of hepatic synthesis or indirectly through effects on IGFBPs.[22] Thissen et al.[27] reported that energy and protein intakes appear to increase IGF levels. The result of the studies about the effect of dietary fat, fiber, or carbohydrates on the IGF axis are inconsistent.[28-30] IGF-1 was associated with carbohydrate intake and this positive association has been observed to be positively associated with the risk of developing breast cancer.[31] In this study, IGF-I was inversely associated with total fat intake. Our finding is inconsistent with the few prior studies which reported positive or no associations between fat intake and IGF-I levels.[29,32] Positive association between high fat diet and high levels of IGF-1 with the risk of developing certain cancers has been observed. However, the finding in this study is consistent with the positive association between both high fat intakes and low IGF-I concentrations and the risk of coronary heart disease.

The study concluded that there was no correlation between IGF-1 and nutritional status, but there was a tendency that higher IGF-1 levels found in overweight. There was a positive correlation between IGF-1 levels and carbohydrate intake, and an inversed correlation between IGF-1 levels and fat intake. We suggest that adolescent girls maintain their weight to achieve normal nutritional status and get macronutrient intake within the recommended range.

Conflict of Interest

The authors of this paper declare there is no conflict of interest regarding this research.

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References

1. Soetjiningsih . *Pertumbuhan somatik pada remaja*. [Somatic growth in Adolescent]. In: Soetjiningsih. *Tumbuh kembang remaja dan permasalahannya*. [Growth and Development in Adeolescent and its Problems. Jakarta: Sagung Seto; 2004.
2. Batubara JRL. Adolescent development (*perkembangan remaja*). Sari Pediatri 2010;12:21–9.
3. Rogol AD, Clark PA, Roemmich JN. Growth and pubertal development in children and adolescents: effects of diet and physical activities. Am J Clin Nutr 2000;72(suppl):521.
4. Stang J. Adolescent nutrition. In: Brown JE, editor. Nutrition through life cycle 4th ed. Belmont: Wadsworth; 2011.
5. Agency of Health Research and Development of Ministry of Health Republic Indonesia. National Basic Health

Research 2010. Jakarta: Ministry of Health Republic Indonesia; 2010.
6. Biro FM, Wien M. Childhood obesity and adult morbidities. Am J Clin Nutr 2010;91(suppl):1499.
7. Engeland A, Bjorge T, Tverdal A, Sogaard AJ. Obesity in adolescence and adulthood and the risk of adult mortality. Epidemiology 2004;15:79–85.
8. Sherwood L. *Prinsip-prinsip endokrinologi: Kelenjar endokrin sentral*. In: Yesdelita N, editor bahasa Indonesia. *Fisiologi manusia dari sel ke sistem*. 6th edition. Jakarta: EGC; 2012.
9. Roith DL, Bondy C, Yakar S, Liu J, Butler A. The somatomedin hypothesis: 2001. Endocr Rev 2001;22:53–74.
10. Tiryakioglu O, Kadiolgu P, Nu C, Hatemi H. Age dependency of serum insulin-like growth factor (IGF)-1 in healthy Turkish adolescents and adults. Indian J Med Sci 2003;57:543–8.
11. Rogers IS, Gunnell D, Emmett PM, Glynn LR, Dunger DB, Holly JM, et al. Cross-sectional associations of diet and insulin-like growth factor levels in 7- to 8-year-old children. Cancer Epidemiol Biomarkers Prev 2005;14:204–12.
12. Shi R, Yu H, McLarty J, Glass J. IGF-1 and breast cancer: a meta-analysis. Int J Cancer 2004;111:418–23.
13. R1 K, Lukanova A. Energy balance and cancer: the role of insulin and insulin-like growth factor-I. Proc Nutr Soc 2001;60:91–106.
14. Lukanova A, Soderberg S, Stattin P, Palmqvist R, Lundin E, Biessy C, et al. Nonlinear relationship of insulin-like growth factor (IGF)-I and IGF-I/IGF-binding protein-3 ratio with indices of adiposity and plasma insulin concentrations (Sweden. Cancer Causes and Control 2002;13:509–16.
15. Kim TH, Chang JC, Kim H, Lee KH, Kong IK. Intense walking exercise affects serum IGF-1 and IGFBP3. J Lifestyle Med 2015;5:21–5.
16. J1 O, Johannsson G, Johansson JO, Lundberg PA, Lindstedt G, Bengtsson BA. Diurnal variation in serum insulin-like growth factor (IGF)-I and IGF binding protein-3 concentrations during daily subcutaneous injections of recombinant human growth hormone in GH-deficient adults. Clin Endocrinol (Oxf 1997;46:63–8.
17. Anand P, Kunnumakara AB, Sundaram C, Harikumar KB, Tharakan A, Lai OS, et al. Cancer is a preventable disease that requires major lifestyle changes. Pharm Res 2008;25:2097–116.
18. Wilson DM, Killen JD, Hammer LD, Vosti C, Miner B, Hayward C, et al. Insulin-like growth factor-I as a reflection of body composition, nutrition, and puberty in sixth and seventh grade girls. J Clin Endocrinol Metab 1991;73:907–912.
19. Gram IT, Norat T, Rinaldi S, Dossus L, Lukanova A, Tehard B, et al. Body mass index, waist circumference and waist–hip ratio and serum levels of IGF-I and IGFBP-3 in European women. Int J Obes 2006;30:1623–31.
20. Faupel-Badger JM, Berrigan D, Ballard-Barbash R, Potischman N. Anthropometric correlates of insulin-like growth factor 1 (IGF-1) and IGF binding protein-3 (IGFBP-3) levels by race/ethnicity and gender. Ann Epidemiol 2009;19:841–9.
21. Boden G. Obesity and free fatty acids (FFA. Endocrinol Metab Clin North Am 2008;37:1–12.
22. Butler AA, Roith DL. Control of growth by the somatropic axis: growth hormone and the insulin-Llike growth factors have related and independent roles. Annu Rev Physiol 2001;63:141–64.
23. Carter S. A description of BMI and the incidence of breast cancer in the premenopausal woman. Electronic Thesis or Dissertation. Walsh University, 2015. https://etd.ohiolink.edu/
24. Renehan AG, Zwahlen M, Minder C, Dwyer, S.T. O', Shalet SM, Egger M. Insulin-like growth factor (IGF)-I, IGF binding protein-3, and cancer risk: systematic review and meta-regression analysis. The Lancet 2004;363:1346–53.

25. Cui X, Willet WC, Hankinson SE. Dietary Fat, Fiber, and Carbohydrate Intake and Endogenous Hormone Levels in Premenopausal Women. Horm Cancer 2010;1:265–76.
26. Kerver JM, Gardiner JC, Dorgan JF, Rosen CJ, Velie EM. Dietary predictors of the insulin-like growth factor system in adolescent females: results from the Dietary Intervention Study in Children (DISC. Am J Clin Nutr 2010;91:643–50.
27. Thissen JP, Ketelslegers JM, Underwood LE. Nutritional regulation of the insulin-like growth factors. Endocr Rev 1994;15:80–101.
28. Holmes MD, Pollak MN, Willett WC, Hankinson SE. Dietary correlates of plasma insulin-like growth factor I and insulin-like growth factor binding protein 3 concentrations. Cancer Epidemiol Biomarkers Prev 2002;11:852–61.
29. Kaklamani VG, Linos A, Kaklamani E, Markaki I, Koumantaki Y, Mantzoros CS. Dietary fat and carbohydrates are independently associated with circulating insulin-like growth factor 1 and insulin-like growth factor–binding protein 3 concentrations in healthy adults. Journal of Clinical Oncology 1999;17(10):3291–8.
30. Nagata C, Shimizu H, Takami R, Hayashi M, Takeda N, Yasuda K. Dietary soy and fats in relation to serum insulin-like growth factor-1 and insulin-like growth factor-binding protein-3 levels in premenopausal Japanese women. Nutr Cancer 2003;45:185–9.
31. Cho E, Spiegelman D, Hunter DJ, Chen WY, Colditz GA, Willet WC. Premenopausal Dietary Carbohydrate, Glycemic Index, Glycemic Load, and Fiber in Relation to Risk of Breast Cancer. Cancer Epidemiol Biomarkers Prev 2003;12:1153–8.
32. Norat T, Dossus L, Rinaldi S, Overvad K, Gronbaek H, Tjonneland A, et al. Diet, serum insulin-like growth factor-I and IGF-binding protein-3 in European women. Eur J Clin Nutr 2007;6:91–98.

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ORIGINAL PAPER

Association between Central Obesity and Waist/Hip Circumference (WHCR) to Dyslipidemia among Adult Patients in Aceh, Indonesia

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Abstract

Introduction: Dyslipidemia is a lipid metabolic disorder marked by high level of total cholestrol, LDL cholesterol and triglyceride, and low level of HDL cholesterol. Dyslipidemia is a risk factor of coronary heart disease, atherosclerosis, acute myocardial infarction, type-2 diabetes, hypertension, and chronic kidney disease. The aim of this study was to evaluate the association between central obesity and waist/hip circumference ratio (WHCR) status to the dislipidemic status in internal medicine clinic patients at Meuraxa Hospital, Aceh, Indonesia.

Methods: The design of the study was analytic observational with cross sectional approach. Purposive sampling was conducted to 64 subjects. Central obesity and WHCR status were determined by measurements while dislipidemic status were collected from patients' medical records.

Results: Based on age, the biggest proportion of dyslipidemia was more than 45 years old (78.1%), and women gender (70.3%). High central obesity status was 76.6%, and high WHCR was 85.5%. High cholesterol was found in 56.3%, with high LDL 78.1%, high triglyceride 59.4% and low HDL 62.5%. There were significant associations between central obesity and dyslipidemic status ($p<0.05$), and between WHCR status and dislipidemic status ($p<0.05$).

Conclusion: We concluded that there were associations between central obesity and WHCR status to dyslipidemic status.

Keywords Central Obesity Dyslipidemia, Waist/Hip Circumference Ratio

Introduction

Dyslipidemia is a lipid metabolic disorder which is marked by high level of total cholesterol, trigliserida, and LDL but low level of HDL cholesterol.[1] Indonesian Basic Health survey data or *Riset Kesehatan Dasar* (RISKESDAS) showed the prevalence of dyslipidemia in Indonesia was 14% in 2007 and had increased to 25–28% in 2013.[2]

Household Survey data obtained the prevalence of dyslipidemia was 44.6% and at the age 25–34 years old was 10%, in which women was 15% higher compared to men, and people above 60 years old had more prevalence of dyslipidemia (56.2%).[3] The increasing cholesterol in blood could cause atherosclerosis. The study conducted by Monica[4] stated that total cholesterol in women averaged 206.6 mg/dl and men 199.8 mg/dl in which tends to develop to high LDL-

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cholesterol, low HDL-cholesterol, high triglycerida, and high blood glucose.

Central obesity is defined by the accumulation subcutaneous and visceral adipose tissues in abdominal wall, which metabolically active in secreting inflammatory mediators. It is well known that adipose tissue in the abdominal visceral wall had more risk for morbidity compared to subcutaneous adipose tissue. The reduction of waist circumference and waist to hip circumference ratio (WHCR) can reduce the risk of central obesity which has a role in metabolic and vascular aspects.[5,6]

The increasing of abdominal fat marked by waist circumference and WHCR are indicators of the increasing free fatty acid production in blood which then become risk factors of atherosclerosis and obesity. Thus, the accumulation of fat in abdominal cavity (central obesity) is associated with metabolic risk causes.[6] Fat is easily accumulated and dissolved in the peritoneum, which in turn is accumulated in blood. Central obesity can be measured with abdominal circumference, which is normally <90 cm in men and <80 cm in women, in which is associated with abdominal sagital diameter which correlated with dislipidemia.[6,7]

Methods :

Subject and Study Design

This study used observational analytic design with cross sectional approach. The study was conducted in Internal Medicine clinic at Meuraxa Hospital Aceh Indonesia from November 23 to November 30, 2016. Nonprobability sampling with consecutive sampling was used to obtain samples who fulfilled the study criteria, i.e. age 18–60 years old, and had blood lipid data from the medical record. Data was analyzed descriptively and association between WHCR and dyslipidemia status was determined using chi-square test.

Results

A total of 64 samples were obtained. Table 1 shows the characteristics based on age, sex, education, occupation, economic status. The results showed that age above 45 years old are more dominant (78.1%), more female (68.7%) with middle education status (37.5%), stay-at-home job (37.5%) and high economic status (46.8%).

Table 1 Characteristics of the subjects (n=64)

Characteristic	Frequency (n)	Percentage (%)
Age, y		
<30	-	-
30–45	14	21.9
45	50	78.1
Gender		
Male	20	31.3
Female	44	68.7
Education status		
Low	20	31.3
Middle	24	37.5
High	20	31.2
Occupation		
Stay-at-home	24	37.5
Employee	20	31.3
Others	20	31.2
Economic Status		
Low	14	21.9
Medium	20	31.3
High	30	46.8

Table 2 Distribution of the subjects based on central obesity, WHCR, and lipid profiles (n=64)

Variables	Frequency (n)	Percentage (%)
Central obesity	46	71.9
High WHCR	55	85.9
High total cholesterol	36	56.3
High LDL-cholesterol	50	62.5
Low HDL-cholesterol	40	62.5
High tryglyceride	38	59.4

As shown in Table 2, there were high prevalence of central obesity, high WHCR and dyslipidemia among the subjects.

Table 3a Association between central obesity and WHCR to total cholesterol (n=64)

	Total cholesterol (n, %)		p
	High	Normal	
Central obesity			
Yes	28 (60.9)	18 (39.1)	0.043
No	8 (44.4)	10 (55.6)	
WHCR			
High	32 (58.2)	23 (41.8)	0.020
Normal	4 (44.4)	5 (55.6)	

Based on Table 3a, the results that 60.9% subjects with central obesity and 58.2% patients with WHCR had high total cholesterol level. Based on chi-square test, there was a significant association between central obesity with total cholesterol (p=0.043), and also between WHCR with total cholesterol (p=0.020).

Table 3b Association between central obesity and WHCR to LDL-cholesterol

	LDL-cholesterol (n, %)		p
	High	Normal	
Central obesity			
Yes	40 (86.9)	6 (13.1)	0.025
No	10 (55.6)	8 (44.4)	
WHCR			
High	45 (81.8)	10 (18.2)	0.028
Normal	5 (55.6)	4 (44.4)	

Based on the results shown in Table 3b, 86.9% patients with central obesity and 81.8% patients with high WHCR had high LDL cholesterol levels. Chi-square test results found a significant relationship between central obesity and LDL-Cholesterol (p=0.025), and also WHCR with LDL-cholesterol profile (p=0.028).

Table 3c Association between central obesity and WHCR to HDL-cholesterol (n=64)

	HDL- cholesterol (n, %)		p value
	Low	Normal	
Central obesity			
Yes	32 (69.6)	14 (30.4)	0.049
No	8 (44.4)	10 (55.6)	
WHCR			
High	38 (69.1)	17 (30.9)	0.041
Normal	2 (22.2)	7 (77.8)	

Result of data analysis in Table 3c showed that 69.6% central obesity patients and 69.1% high WHCR patients had low HDL levels. There was a significant relationship between central obesity with HDL-cholesterol level (p=0.049), and also between WHCR and HDL-cholesterol level (p=0.041).

Table 3d Association between central obesity and WHCR to triglyceride (n=64)

	Triglyceride (n, %)		p
	High	Normal	
Central obesity			
Yes	30 (65.2)	16 (34.8)	0.037
No	8 (44.4)	10 (55.6)	
WHCR			
High	35 (63.6)	20 (36.4)	0.010
Normal	3 (33.3)	6 (66.7)	

Based on Table 3d, 65.2% central obesity patients and 63.6% patients with high WHCR had high triglyceride levels. Chi-square test results showed there were significant relationships between central obesity and triglyceride levels (p=0.037), and also between WHCR and triglyceride levels (p=0.010).

Discussion

The result of this study had similar findings to Hafnizar et al.[9] study which stated that WHCR is associated to cardiovascular diseases and dyslipidemia. The study by Abete et al.[10] stated that WHCR and central obesity can be used as indicator of dyslipidemia and metabolic syndrome risk factors. The study of Lee et al.[11] shows that waist – to –hip ratio (WHR) has the best potential for predicting subclinical atherosclerosis compared to Body Mass Index (BMI) and waist circumference (WC) in post menopausal women. Central obesity is one of the risk factors for metabolic syndrome and dyslipidemia. Yekdes study has a central obesity relationship with coronary heart disease, WHCR and central obesity and dyslipidemia are parameters of pathogenesis of coronary heart disease.[13] Affanti Study has a central obesity relationship with HDL and LDL levels. Central obesity or excessive accumulation of fat causes increased levels of fat in the blood resulting in elevated cholesterol levels.[14] Medika Research has a relationship of central obesity and WHCR with HDL and LDL cholesterol. A person with central

obesity and a high WHCR has a 3 times chance of having higher LDL cholesterol and lower LDL in comparison to a non-central obesity person. Central obesity and excessive WHCR are risk factors for diabetes mellitus type 2, hypertension, coronary heart disease and dyslipidemia. So it makes increased cholesterol production by acetyl-coA in the liver by 15% to 25% if a person is high in saturated fat.[15] Rasdini Study has a central obesity relationship with total cholesterol levels this is due to visceral fat is more associated with dyslipidemia and metabolic syndrome than total body fat.[16] Ma,rufi et al. [17] study state that women with excess abdominal circumference and high WHCR risk 1.5 times increased cholesterol LDL and at risk for dyslipidemia and cardiovascular disease.

Conclusion

This study found association between central obesity and WHCR status to dislipidemia among subjects in internal medicine clinic at Meuraxa Hospital Aceh Indonesia. It is then suggested to do screening periodically by using waist abdominal and hip circumference measures as prevention efforts toward dyslipidemia and risk of cardiovascular diseases.

Conflict of Interest

The authors of this paper declare there is no conflict of interest regarding this research.

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References

1. World Health Organization. Noncommunicable diseases country profiles 2014.
2. Badan Penelitian dan Pengembangan Kesehatan. Survei Kesehatan Rumah Tangga 2004. MoH Republic of Indonesia. 2005 76–79.
3. Janssen I, Katzmarzyk PT, Ross R. Body Mass Index, Waist Circumference, and Health Risk. Arch Intern Med 2002;162:2074–9.
4. Setiono LY, Suhartono T, Purwoko Y. Dislipidemia pada obesitas dan tidak obesitas Di RSUP dr. Kariadi dan laboratorium klinik swasta di kota semarang (Doctoral dissertation, Fakultas Kedokteran Universitas Diponegoro).
5. Riska D. Hubungan lingkar pinggang dengan kadar trigliserida pada pasien rawat jalan dislipidemia di Puskesmas Janti Kota Malang. Jurusan Gizi Fakultas Kedokteran Universitas Brawijaya.
6. Al-Kaabba AF, Al-Hamdan NA, El Tahir A, Abdalla AM, Saeed AA, Hamza MA. Prevalence and correlates of dyslipidemia among adults in Saudi Arabia: results from a national survey. Open J Endocr Metab Dis 2012 Nov;2(04):89.
7. Thompson PD, Buchner D, Pina IL, Balady GJ, Williams MA, Marcus BH, Berra K, et al. Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition,Physical Activity, and Metabolism (Subcommittee on Physical Activity. Circulation 2003 Jun;107(24):3109–16.
8. Chainurridha, Sucipto K.W, Husnah, Ibrahim T. Hubungan Antara Indeks Massa Tubuh dan Lingkar Perut dengan Dislipidemia. Online Theses and Dissertation Unsyiah Medical School. 2014
9. Hafnizar W, Imran, Husnah. Perbedaan Lingkar Pinggang dengan Rasio Lingkar

Pinggang. Online Theses and Dissertation Unsyiah Medical School. 2016
10. Abete I, Arriola . L, Etvezarreda N, Mozo I, Moreno – Iribrs C, Amiano P et al. Association between different obesity measures and the risk of stroke in the epic sponish cohort. European Journal of Nutrition 2015;54(3):365.
11. Lee HJ, Hwang SY, Hong HC, Ryu JY, Seo JA, Kim SG, et al. Waist-to-hip ratio is better at predicting subclinical atherosclerosis than body mass index and waist circumference in postmenopausal women. Maturitas 2015 Mar;80(3):323–8.
12. Grundy SM. An International Atherosclerosis Society Position Paper: global recommendations for the management of dyslipidemia. Journal of clinical lipidology 2013 Dec;7(6):561–5.
13. Yekdes.AC. The Relationship Between Waist Circumference, Body Mass Index and Coronary Artery Disease in Patients With Metabolic Syndrome. Indian Journal of Medical Research and Pharmaceutical Sciences. 2017:4(june):1–9.
14. Affanti KAN. Hubungan Indeks Massa Tubuh dan Asam Lemak Jenuh Dengan serum Rasio LDL/HDL Lansia. Thesis, Faculty of Medicine, Diponegoro University. 2015:4(2).
15. Prasetya M, Oenzil F, Karani Y. Hubungan Indeks Masa Tubuh dan Lingkar Perut dengan Low Density Lipoprotein pada Pasien Penyakit Jantung Koroner di Poliklinik Jantung RSUP Dr. M. Djamil Padang. Jurnal Kesehatan Andalas. 2015 Sep 1;4(3).
16. Rasdini IG. Hubungan Lingkar Pinggang Dengan Kadar Kolesterol LDL Pasien Penyakit Jantung Koroner di Ruang ICCU RSUP SANGLAH Denpasar. Jurnal Kesehatan 2016 Aug;7(1):46–51.
17. Ma'rufi R, Rosita L. Hubungan Dislipidemia dan Kejadian Penyakit Jantung Koroner. JKKI: Jurnal Kedokteran dan Kesehatan Indonesia 2015;6(1):47–53.

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ARTICLE REVIEW

Probiotic Interventions to Optimize the Infant and Child Microbiota

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Abstract

The optimal healthy microbiota during early life still needs further evaluation. Pre- and probiotics are commonly used as supplementation in infant formula. Prebiotic oligosaccharides stimulate the growth of bifidobacteria aiming to mimic the gastrointestinal microbiota of breastfed infants. In general, results with prebiotics in therapeutic indications are disappointing. Studies suggest that probiotic supplementation may be beneficial in prevention and management of disease such as e.g., reducing the risk of necrotizing enterocolitis in preterm infants, prevention and treatment of acute gastroenteritis in infants, etc. Although many studies show promising beneficial effects, the long-term health benefits and eventual risks of probiotic supplementation during early life are not clear. It is likely that ongoing research will result in the use of specific probiotic organisms and/or prebiotic oligosaccharides during the first 1,000 days of life, with the goal to develop a healthy microbiota from conception over birth into the first two years of life with a lowered risk of infections and inflammatory events.

Keywords gastrointestinal microbiota, infant feeding, prebiotic, probiotic

When is infant microbiota optimal?

The question arises immediately: do we know the optimal healthy gastro-intestinal (GI) microbiota for the infant and child? The answer is probably negative. The important differences between the GI microbiota development between infants born through cesarean section versus natural delivery or standard infant formula feeding versus breastfeeding are well known. We also know that the GI microbiota of the mother is influenced by medications (antibiotics, anti-acid medications, etc), diet, stress and many other factors.[1] The GI microbiota of the breastfed baby born vaginally is in general considered as the "healthy microbiota", but depends on the GI microbiota of the mother. More data need to be collected to better define the "optimal healthy GI microbiota". The stepwise microbial gut colonization process may be initiated already prenatally by a distinct microbiota in the placenta and amniotic fluid.[2] The clinical meaning of these findings needs to be further evaluated. A necrotizing enterocolitis (NEC) associated gut microbiota has been identified in meconium samples. Clostridium perfringens continues to be associated with NEC from the first meconium until just before NEC onset. In contrast, in post-meconium, increased numbers of staphylococci were negatively associated with NEC.[3] Pre-term birth, cesarean section, formula feeding, antibiotic use and malnutrition have been linked to dysbiosis, which in turn is associated with several pathologies

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such as NEC, inflammatory bowel diseases, colic, and allergies.

Probiotics are living microorganism that, when administered in sufficient amount, have a health benefit for the host. Prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, which can improve host health. Synbiotics are a mixture of pre- and probiotics.

Based on the current literature, a case can be made for the use of specific sets of probiotic organisms with the goal of promoting a healthy pregnancy to birth, and a healthy start to life with lowered risk of infections and inflammatory events.[4] The mechanisms of specific probiotic strains administered during the perinatal period suggest that probiotic interventions in early life can be envisaged for disease prevention in both healthy offspring and offspring at risk of chronic disease. There is evidence that manipulation of the infant microbiota by using pre- or probiotics can restore the ecological balance of the microbiota and may mitigate potential negative effects on the developing immune system, when use of antibiotics cannot be avoided.[5]

Probiotics

Unfortunately, the term "probiotic" seems to cause confusion. The taxonomic ranking for classification of probiotics is as follows: there is a domain (bacteria, fungi), a lineage (eg Furmicutes), a class (eg Lactobacilli), an order (eg Lactobacillales), a family, a genus, a species and subspecies. Most probiotics are bacteria, but the yeast Saccharomyces boulardii is one of the best studied, especially in gastroenterologic indications (Fig 1). Probiotics do not colonize the host. This means, that one to two weeks after stopping the administration of a probiotic strain, it disappears from the GI microbiota. The European Food Safety Authority considers "probiotics" as a medical claim, what results in the prohibition of the term on products or for communication by companies. More and more patents are given to specific probiotics with specific claims: fat metabolism, obesity, oral health, anticancer treatments, cardiovascular disorders, diabetes, immunomodulation, allergy, viral diseases such as AIDS, and others. A lot of research on probiotics is now focusing on other areas such as veterinary medicine and dermatology.

Traditional cuisines do contain a lot of fermented foods and thus probiotics. Fermented foods are foods produced or preserved by the action of microorganisms. The use of bacteria such as Lactobacillus results in the making of foods such as yoghurt and sauerkraut. The science of fermentation is known as zymology. Many pickled or soured foods are fermented as part of the pickling or souring process.

The market is overloaded with food supplements containing probiotics. However, there is no guarantee for the quality of such a product. There can be problems at the manufacturing level, but also at the level of survival during shelf life, or poor resistance to gastric acid.[6–8] In other words, there is a world of difference between using probiotics as a healthy eating habit or using probiotics as medication.

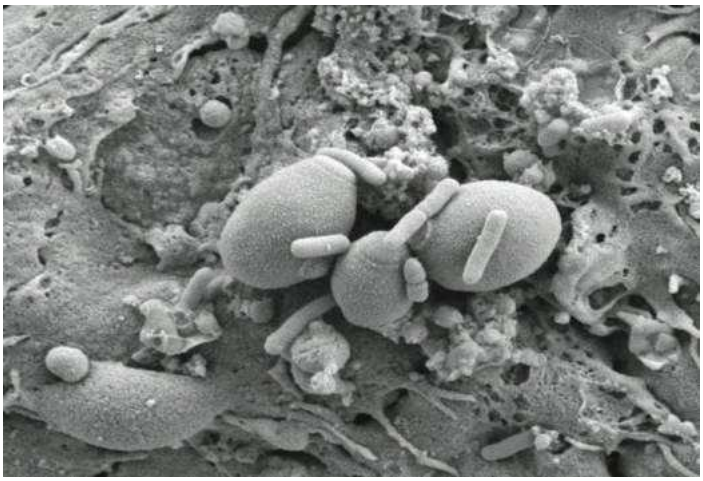

Figure 1 Illustration of the size difference between a yeast probiotic (*Saccharomyces boulardii*) and bacteria (Salmonella)

Probiotics can just be added to food, such as in infant formula. Probiotics are also added to foods such as chocolate and ice cream. Many yoghurts are enriched with probiotics. However, it is obvious that the targeted effect of probiotics in food differs in both situations substantially: while in infant formula there is a clear medical purpose, probiotics added to food such as ice cream and

chocolate have a merely marketing goal claiming to improve general wellbeing. Probiotics used for medical purposes are often commercialized as pills or sachets. Some products are also on the market in liquid form and are administered as drops. Slow release tablets (e.g. to be put in a specially designed infant pacifier) were developed.[9] Especially for respiratory tract indications, probiotics sprays have been developed.[10] A novel probiotic delivery system has been developed in which probiotics are grown as a biofilm on microspheres, allowing enhanced efficacy with only a single treatment.[11]

It is beyond doubt that for specific medical purposes the effect of probiotic is strain-specific. This is illustrated by the following findings. Breastfeeding women received probiotic milk or placebo from 36 weeks of gestation up to 3 months postnatally while breast-feeding.[12] The probiotic milk contained Lactobacillus (L.) rhamnosus GG, L. acidophilus La-5, and Bifidobacterium animalis subsp. lactis Bb-12. Only the L. rhamnosus GG bacteria colonized the children at 10 days and at 3 months of age.[12] Different probiotic bacteria seem to have different ability to transfer from the mother to the child. This is in line with the finding that L. rhamnosus strains present in breastmilk were isolated and characterized and should be further characterized.[13] However, the relevance of strain specificity depends on the probiotic property that is looked for. Lactobacilli that survive gastric acid and bile will be fermented in the colon. Depending on the effect that is looked for, strain specificity is more or less important. The impact of probiotics on the development of the immune system in formula fed infants was recently illustrated by the findings of the TEDDY study.[14] Early probiotic supplementation (at the age of 0–27 days) was associated with a decreased risk of islet autoimmunity when compared with probiotic supplementation after 27 days or no probiotic supplementation.[14] It was concluded that early probiotic supplementation may reduce the risk of islet autoimmunity in children at the highest genetic risk of diabetes.[14]

Many probiotic products are a combination of different strains. However, multi-species can as well do better than worse as single strains products.[15,16] In general, high dosages are more effective than low, although the number of dose-efficacy studies is limited.[17] Although, some meta-analyses come exactly to the opposite conclusions: in patients with irritable bowel syndrome, single probiotics at a low dose and with a short treatment duration appear to be more effective in improving overall symptom response and quality of life.[18] Older literature also suggest that the earlier probiotics are started (in the treatment of acute gastroenteritis), the greater the effect.[19]

In general, probiotics have the label to be "GRAS" (generally regarded as safe). However, side effects, mostly sepsis, are reported. But, probiotics have also been used safely in patients with immune deficiencies, showing a beneficial effect on growth only in HIV-positive infants.[20] The increased use of probiotics in vulnerable immune insufficient preterm infants may lead to an increased risk of severe complications such as sepsis with the probiotic.[21]

Although generalization should be avoided, as efficacy for medical indications is strain specific, it can be said that there is evidence that some strains do prevent atopic dermatitis (especially if also given to the mother during pregnancy). To date, expert bodies do not generally recommend probiotics for allergy prevention, although the World Allergy Organization (WAO) in their recently developed guidelines suggests considering using probiotics in pregnant women, during breastfeeding and/or to the infant if at high risk of developing allergic disease (based on heredity).[22] However, in concordance with other expert bodies, the WAO guideline panel stressed the low level of evidence and the need for adequately powered randomized controlled trials and a more standardized approach before clinical recommendations on specific strains, dosages and timing can be given.[22] Several meta-analyses have reported a moderate benefit of probiotics for eczema prevention, and the most consistent effect has been observed with a combined perinatal intervention in infants at high risk of allergic disease due to familial predisposition.[22] Multi-strain probiotics appeared to be most effective for eczema prevention.[22]

Probiotic strains have also been shown to prevent infectious disease such as community

acquired and nosocomial gastroenteritis, respiratory tract and urinary tract infections. Infants receiving Bifidobacterium BB-12 were reported to have experienced fewer respiratory tract infections (risk ratio (RR): 0.87; 95% confidence interval (CI): 0.76, 1.00; p=0.033) than controls.[23] No significant differences between the groups were observed in reported GI symptoms, otitis media, or fever.[23]

Probiotics also decrease the incidence and severity of NEC in preterms. Strategies such as antenatal glucocorticoids, postnatal breast milk feeding, and cautious approach to enteral feeding failed to eliminate NEC because these strategies did not address the complexity of the pathogenesis.[24] Probiotics seem to be the most significant advance in NEC prevention at present because of the significant range of beneficial effects at various levels of gut function and defense mechanism.[24] However not all studies are positive, as shown by a study with B breve BBG-001 for prevention of NEC and late-onset sepsis in very preterm infants.[25] New ways of administration of probiotics are developed, specifically for preterm infants.[26] A single dose of Lactobacillus biofilm grown on biocompatible microspheres was shown to significantly reduce NEC incidence and severity in rats.[26] Therefore, the risk/benefit should be considered before starting routine administration. Standard care in the Neonatal Intensive Care Units in the western world has resulted in a very low incidence of NEC. Oral probiotic given to VLBW infants do not affect neuromotor, neurosensory and cognitive outcomes at 18–24 months' corrected age.[27] Rapid changes of nasogastric tubes may lead to a decreased incidence of NEC without the risk for sepsis.[28]

Probiotics also shorten the duration of infectious diseases, such as gastroenteritis. Probiotics added to infant formula have been shown in many older studies to possibly protect for infectious gastroenteritis, although some studies did not show a benefit. However, there was no study that suggested an increased risk of gastroenteritis. They are also effective in the prevention and treatment of antibiotic associated diarrhea (AAD). Moderate quality evidence suggests a protective effect of probiotics in preventing AAD (RR 0.46; 95% CI 0.35 to 0.61), with a number needed to treat of 10.[29]

Probiotics may also have a role in infantile colic and in irritable bowel syndrome, especially older children and adults. The management of infantile colic in formula fed infants is still a challenge. L. reuteri DSM 17938 was ineffective in formula fed infants.[30] L. GG in infants treated in tandem with behavioral support and a cow's milk elimination diet did not provide additional treatment effect for diary-verified colic crying although parental report of crying suggested the probiotic intervention effective.[31] A synbiotic (a mixture of seven probiotic strains plus FOS (Fructooligosaccharide)) significantly improved colic symptoms in comparison with placebo.[32] Several studies were performed with L. reuteri DSM 17938 in breastfed infants presenting with infantile colic.[33]

Probiotics may also decrease regurgitation. Treated infants demonstrated a reduction in daily regurgitations at the end of treatment, three neonates in the placebo group only needed simethicone for GI pain, sIgA level was similar in both groups.[34]

Probiotics result in a 10% eradication rate of Helicobacter pylori infection, although it is not known whether this is due to a true better eradication or better compliance to the eradication treatment because of a decrease of adverse effects (antibiotic associated diarrhea). Probiotics have been shown to be effective in the treatment of constipation in adults, but not in children. Literature on the efficacy of probiotics in inflammatory bowel disease is in general disappointing, certainly in pediatrics. The above list is not exhaustive, but indicates the broad spectrum of possible indications, going from general wellbeing over immune mediated diseases to infections. But negative results have also (seldom) been reported. Lactobacillus acidophilus (LAVRI-A1) was reported to increase the risk of atopic dermatitis compared to placebo.[35]

Probiotics during pregnancy

Probiotics administered during pregnancy (and breastfeeding) to the mother can be found in the GI microbiota of the woman and has been shown for some strains to possibly have a preventive effect of the frequency and severity of atopic dermatitis in the infant. However, the literature on the effect of

probiotics on the infant when given to the mother during pregnancy is quiet contradictory. According to some authors, currently evidence does not indicate that probiotic supplementation reduces the risk of developing allergy in children.

Current analysis of the role of probiotics in the prevention of atopic dermatitis reveals that a positive effect may be related to the type of probiotic strain used, the method of administration, onset time, as well as the dose size and duration of treatment.[36] Panduru et al.[37] concluded in a meta-analysis that probiotics have a protective role in atopic dermatitis prevention if they are administered during the pre- and postnatal period, in both the general and at allergic risk population. Maternal probiotic ingestion alone may be sufficient for long-term reduction in the cumulative incidence of atopic dermatitis, but not other allergy related diseases.[38] The guideline of the World Allergy Organisation (WAO) panel determined that there is a likely net benefit from using probiotics resulting primarily from prevention of eczema. The WAO guideline panel suggests: a) using probiotics in pregnant women at high risk for having an allergic child; b) using probiotics in women who breastfeed infants at high risk of developing allergy; and c) using probiotics in infants at high risk of developing allergy. All recommendations are conditional and supported by very low quality evidence.[39]

Prebiotics

Many of the production and conservation difficulties such as survival during production and shelflife with probiotics are not valid for prebiotics. Prebiotics stimulate the GI microbiota of the host, whereas probiotics just add one or couple of strains. According to some data, they may have prolonged effect. Some data suggest that if infant are supplemented from birth up to six months, that the bifidogenic effect can still be observed at the age of 12 months.[40] Also prebiotics are generic, and findings of one prebiotic cannot be extrapolated to another one.[41] The number of comparative and dose-efficacy studies is extremely limited.

The advantages of prebiotics in infants and children are mostly limited to prevention studies with infant formula supplemented with prebiotics oligosaccharides. While some studies show a benefit, others fail to do so, but the outcome in the prebiotic group is never worse than the comparator group. Most studies on the efficacy of prebiotics in therapeutic indications are disappointing. The effect of some prebiotic oligosaccharides on the gastro-intestinal microbiota is clear, as the effect on stool frequency and composition in non-constipated infants, bringing defecation pattern in formula fed infants closer to the pattern in breastfed infants. Literature is not conclusive on other possible effects such as decrease of infection, decrease of atopic dermatitis, and so on. Compared to probiotics, for which side effects are scarce but reported, adverse effects of prebiotics in infants are not reported.

Synbiotics

Data on the combination of pre- and probiotics in infants and children are quiet limited. Most studies regard short-term therapeutic interventions. Mean±standard deviation infection rates in infants followed up to 12 months were 4.9±3.2 per infant per year in the B.lactis+GOS (Galacto-oligosaccharide)/FOS group and 4.5±3.0 per infant per year in the B lactis group (p=0.18). Mean daily weight gain was slightly lower in the B.lactis+GOS/FOS than the B lactis group (16.1±2.9 vs 16.6±2.6 g/day, p=0.046), but was not clinically significant.[42] Other outcomes were not significantly different between groups. Formulas containing B.lactis+GOS/FOS did not reduce infection rates beyond those containing only B lactis.[42] Chang et al.[43] conclude in their meta-analysis that evidence supports the use of synbiotics for the treatment of atopic dermatitis, particularly synbiotics with mixed strains of bacteria and for children aged 1 year or older. Nevertheless, infant formula companies promote the combination of pre- and probiotics in infant formula. Although this evolution does not seem to induce any increased risk for adverse effects, the benefit has not been shown.

Conclusion

The knowledge on the importance of the GI microbiota to the development of wellbeing and

general health is increasing, and has been a focus of research during the past 10 years. The development of a healthy GI microbiota from conception throughout the first years of life will have lifetime long consequences. The use of prebiotics, probiotics and synbiotics in the prevention and treatment of different health conditions is increasing. If probiotic and prebiotic products are intended to be used in medical indications with the intention to claim a health benefit, at least two independent clinical studies are needed with the commercialized product. If products are commercialized with the intention to contribute to healthy eating habits, such high quality research is not needed. However, in that case, it is not justified to have any claim. In order to reduce confusion, a different terminology for "healthy foods with pre- and probiotics" and "specific products claiming a targeted health benefit" would be welcomed. The earlier proposed term "biotherapeutic agent" does not fulfill the requirements, as the concerned effects regard also prevention, probably even more than therapy.

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References

1. Odamaki T, Kato K, Sugahara H, Hashikura N, Takahashi S, Xiao JZ, et al. Age-related changes in gut microbiota composition from newborn to centenarian: a cross-sectional study. BMC Microbiol 2016;16:90.
2. Collado MC, Rautava S, Aakko J, Isolauri E, Salminen S. Human gut colonisation may be initiated in utero by distinct microbial communities in the placenta and amniotic fluid. Sci Rep 2016;6:23129.
3. Heida FH, Zoonen, A . G. van , Hulscher JB, Bj TK, Wessels R, Kooi EM, et al. A necrotizing enterocolitis-associated gut microbiota is present in the meconium: results of a prospective study. Clin Infect Dis 2016;62:863–70.
4. Reid G, Kumar H, Khan AI, Rautava S, Tobin J, Salminen S. The case in favour of probiotics before, during and after pregnancy: insights from the first 1,500 days. Benef Microbes 2016;7:353–62.
5. Rutten NB, Rijkers GT, Meijssen CB, Crijns CE, Oudshoorn JH. K. van der , et al. Intestinal microbiota composition after antibiotic treatment in early life: the INCA study. BMC Pediatr 2015;15:204.
6. Hamilton-Miller JM, Shah S, Smith CT. Probiotic" remedies are not what they seem. BMJ 1996;312:55-6.
7. Vanhee LM, Goemé F, Nelis HJ, Coenye T. Quality control of fifteen probiotic products containing Saccharomyces boulardii. J Appl Microbiol 2010;109:1745–52.
8. Huys G, Botteldoorn N, Delvigne F. De , Heyndrickx M, Pot B, et al. Microbial characterization of probiotics--advisory report of the Working Group "8651 Probiotics" of the Belgian Superior Health Council (SHC. Mol Nutr Food Res 2013;57:1479–504.
9. Taipale T, Pienihäkkinen K, Isolauri E, Jokela JT, Söderling EM. Bifido animalis subsp. lactis BB-12 in reducing the risk of infections in infancy. Br J Nutr 2011;105:409–16.
10. Santagati M, Scillato M, Muscaridola N, Metoldo V. La , Stefani S. Colonization, safety, and tolerability study of the Streptococcus salivarius 24SMBc nasal spray for its application in upper respiratory tract infections. Eur J Clin Microbiol Infect Dis 2015;34:2075–80.
11. Olson JK, Rager TM, Navarro JB, Mashburn-Warren L, Goodman SD, Besner GE. Harvesting the benefits of biofilms: A novel probiotic delivery system for the prevention of necrotizing enterocolitis. Journal of pediatric surgery 2016;51(6):936–41.
12. Dotterud CK, Avershina E, Sekelja M, Simpson MR, Rudi K, Storrø O, et al. Does

13. maternal perinatal probiotic supplementation alter the intestinal microbiota of mother and child. J Pediatr Gastroenterol Nutr 2015;61:200–7.
14. Panya M, Lulitanond V, Rattanachaikunsopon P, Srivoramas T, Chaiwong T. Isolation, Identification, and Evaluation of Novel Probiotic Strains Isolated from Feces of Breast-Fed Infants. Journal of the Medical Association of Thailand= Chotmaihet thangphaet 2016;99.
15. Uusitalo U, Liu X, Yang J, Aronsson CA, Hummel S, Butterworth M, et al. Association of Early Exposure of Probiotics and Islet Autoimmunity in the TEDDY Study. JAMA Pediatr 2016;170:20–8.
16. Grandy G Medina M, , Soria R, Terán CG, Araya M . Probiotics in the treatment of acute rotavirus diarrhoea. A randomized, double-blind, controlled trial using two different probiotic preparations in Bolivian children. BMC Infect Dis 2010;10:253.
17. Chapman CM, Gibson GR, Rowland I. In vitro evaluation of single- and multi-strain probiotics: Inter-species inhibition between probiotic strains, and inhibition of pathogens. Anaerobe 2012;18:405–13.
18. Shornikova AV, Casas IA, Isolauri E, Mykkänen H, Vesikari T. Shornikova AV. Lactobacillus reuteri as a therapeutic agent in acute diarrhea in young children. J Pediatr Gastroenterol Nutr 1997;16:1103–7.
19. Zhang Y, Li L, Guo C, Mu D, Feng B, Zuo X, et al. Effects of probiotic type, dose and treatment duration on irritable bowel syndrome diagnosed by Rome III criteria: a meta-analysis. BMC Gastroenterol 2016;16:62.
20. Rosenfeldt V, Michaelsen KF, Jakobsen M, Larsen CN, MØller PL, Pedersen P, et al. Effect of probiotic Lactobacillus strains in young children hospitalized with acute diarrhea. The Pediatric infectious disease journal 2002;21(5):411–6.
21. Steenhout PG, Rochat F, Hager C. The effect of Bifido lactis on the growth of infants: a pooled analysis of randomized controlled trials. Ann Nutr Metab 2009;55:334–40.
22. Zbinden A, Zbinden R, Berger C, Arlettaz R. Case series of Bifidobacterium longum bacteremia in three preterm infants on probiotic therapy. Neonatology 2015;107:56–9.
23. West CE. Probiotics for allergy prevention. Benef Microbes 2016;7:171–9.
24. Taipale TJ, Pienihäkkinen K, Jokela JT, Söderling EM. Bifidobacterium animalis subsp. lactis BB-12 in reducing the risk of infections in early childhood. Pediatr Res 2016;79:65–9.
25. Chen AC, Chung MY, Chang JH, Lin HC. Pathogenesis implication for necrotizing enterocolitis prevention in preterm very-low-birth-weight infants. J Pediatr Gastroenterol Nutr 2014;58:7–11.
26. Costeloe K, Hardy P, Juszczak E, Wilks M, Millar MR. P.I.S.C. (Probiotics) . Bifidobacterium breve BBG-001 in very preterm infants: a randomised controlled phase 3 trial. Lancet 2016;387:649–60.
27. Olson JK, Rager TM, Navarro JB, Mashburn-Warren L, Goodman SD, Besner GE. Harvesting the benefits of biofilms: A novel probiotic delivery system for the prevention of necrotizing enterocolitis. Journal of pediatric surgery 2016;51(6):936–41.
28. Akar M, Eras Z, Oncel MY, Arayici S, Guzoglu N, Canpolat FE, et al. Impact of oral probiotics on neurodevelopmental outcomes in preterm infants. The Journal of Maternal-Fetal & Neonatal Medicine 2017;30(4):411–5.
29. Petersen SM, Greisen G, Krogfelt KA. Nasogastric feeding tubes from a neonatal department yield high concentrations of potentially pathogenic bacteria [mdash] even 1 d after insertion. Pediatric research 2016;80(3):395–400.
30. Goldenberg JZ, Lytvyn L, Steurich J, Parkin P, Mahant S, Johnston BC. Probiotics for the prevention of pediatric antibiotic-associated diarrhea. Cochrane Database Syst Rev 2015;12.
31. Pärtty A, Lehtonen L, Kalliomäki M, Salminen S, Isolauri E. Probiotic Lactobacillus rhamnosus GG therapy and microbiological programming in infantile

colic: a randomized, controlled trial. Pediatr Res 2015;78:470–5.
32. Kianifar H, Ahanchian H, Grover Z, Jafari S, Noorbakhsh Z, Khakshour A, et al. Synbiotic in the management of infantile colic: a randomised controlled trial. J Paediatr Child Health 2014;50:801–5.
33. T1 H, Matsuyama M, David M, Hill RJ. Infant colic - What works: a systematic review of interventions for breast-fed infants. J Pediatr Gastroenterol Nutr 2016;62:668–86.
34. Garofoli F, Civardi E, Indrio F, Mazzucchelli I, Angelini M, Tinelli C, et al. The early administration of Lactobacillus reuteri DSM 17938 controls regurgitation episodes in full-term breastfed infants. Int J Food Sci Nutr 2014;65:646–8.
35. Taylor AL, Dunstan JA, Prescott SL. Probiotic supplementation for the first 6 months of life fails to reduce the risk of atopic dermatitis and increases the risk of allergen sensitization in high-risk children: a randomized controlled trial. J All Clin Immunol 2007;119:184–91.
36. Rather IA, Bajpai VK, Kumar S, Lim J, Paek WK, Park YH. Probiotics and atopic dermatitis: an overview. Front Microbiol 2016;7:507.
37. Panduru M, Panduru NM, Sălăvăstru CM, Tiplica GS. Probiotics and primary prevention of atopic dermatitis: a meta-analysis of randomized controlled studies. J Eur Acad Dermatol Venereol 2015;29:232–42.
38. Simpson MR, Dotterud CK, Storrø O, Johnsen R, Øien T. Perinatal probiotic supplementation in the prevention of allergy related disease: 6 year follow up of a randomised controlled trial. BMC Dermatol 2015;15:13.
39. Fiocchi A, Pawankar R, Cuello-Garcia C, Ahn K, Al-Hammadi S, Agarwal A, et al. World Allergy Organization-McMaster University Guidelines for Allergic Disease Prevention (GLAD-P): Probiotics. World Allergy Organ J 2015;8:4.
40. Salvini FJ. Riva E, Salvatici E, Boehm G, Jelinek J, Banderali G, Giovannini M. A specific prebiotic mixture added to starting infant formula has long-lasting bifidogenic effects. Nutr 2011;141:1335–9.
41. Veereman-Wauters G, Staelens S. Van de , Plaskie K, Wesling F, Roger LC, et al. Physiological and bifidogenic effects of prebiotic supplements in infant formulae. J Pediatr Gastroenterol Nutr 2011;52:763–71.
42. Bocquet A, Lachambre E, Kempf C, Beck L. Effect of infant and follow-on formulas containing B lactis and galacto- and fructo-oligosaccharides on infection in healthy term infants. J Pediatr Gastroenterol Nutr 2013;57:180–7.
43. Chang YS, Trivedi MK, Jha A, Lin YF, Dimaano L, García-Romero MT. Synbiotics for Prevention and Treatment of Atopic Dermatitis: A Meta-analysis of Randomized Clinical Trials. JAMA Pediatr 2016;170:236–42.

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ORIGINAL PAPER

Correlation between Carbohydrate, Protein and Fat Intake with Serum C-Reactive Protein Level in Lung Cancer Patients Stage IIIB-IV

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Abstract

Introduction: The aim of the study is to determine the correlation between carbohydrates, fat and protein intake with the serum C-Reactive-Protein level in lung cancer patients stage IIIB – IV. The progression of lung cancer is influenced by immune system, genetic factors and inflammatory response, therefore CRP can be relied as one of the parameters for predicting cancer cell growth.
Methods: A cross sectional study was conducted in Dharmais Cancer Hospital Jakarta. Subjects were recruited by consecutive sampling, 49 subjects with lung cancer stage IIIB–IV who currently not receiving any treatment in Dharmais Hospital participating in this study.
Results: The mean age of subject was 55.82 ± 12.26 years old and 63.3% were male. The median value of CRP is 23.82 (0.30–207.29) mg/L. The correlation between carbohydrate, protein and fat intake with serum CRP level (r=0.015 and p=0.919; r=-0.165 and p=0.257; r=0.003 and p=0.986, respectively).
Conclusion: This study did not show significant correlation between carbohydrate, protein and fat intake with serum CRP level. In further analysis we did found that there was a negative, but non-significant correlation between protein intake and serum CRP level in cancer patient stage IV, as well as fat intake and serum CRP level.

Keywords C-Reactive-Protein, Inflammation, Lung Cancer, Carbohydrate intake, Protein Intake and Fat Intake

Introduction

Cancer is one of the non-communicable diseases with high incidence rates and the leading cause of death worldwide. Lung cancer is a type of cancer with the highest incidence and the leading cause of death from cancer in men.[1] Based on data from the Department of Pulmonology and Respiratory Medicine at the Faculty of Medicine University of Indonesia – Persahabatan General Hospital, the incidence of lung cancer has increased more than five-folds in the last 10 years, and most patients come at an advanced stage (IIIB/IV).[2] Malnutrition is a frequent manifestation in cancer patient and can negatively affect the outcome of treatments, thus a significant contributor to morbidity and mortality.[3] Studies have demonstrated that 30% to 87% of cancer patients are diagnosed with malnutrition.[4]

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Malnutrition in cancer patient is multifactorial and can be contributed to several factors: local effects of a tumor, the host response to the tumor, anticancer therapies, reduced food intake due to systemic effects of the disease, local tumor effects, psychological effects or adverse effects of treatment, and alterations in nutrient metabolism and resting energy expenditure (REE).[5] The interactions between cancer cells and normal host cells form a tumor microenvironment that causes changes in carbohydrate, protein and fat metabolism in the host body.[6] Metabolic changes that occur aim to provide the supply of energy and substrate that support the rapid growth of cancer cells.[7] Nearly a century, Otto H Warburg stated that cancer cells take glucose from their surroundings more than twice as normal cells and most of the glucose is converted into lactate, regardless of the presence of oxygen. In cancer patients, in addition to the above glycolysis changes, there is also insulin resistance.[8,9]

Changes in protein metabolism in cancer patients are characterized by decreased protein muscle synthesis, increased muscle protein catabolism and increased synthesis of acute phase proteins, such as C-reactive protein, as a response to inflammation.[10,11] Insulin resistance leads to increased gluconeogenesis pathways and decreases protein muscle synthesis. Amino acids, especially alanine are broken down for precursors of glucose formation.[9,12] Changes in lipid metabolism occur through increased lipolysis, decreased lipogenesis and adipogenesis, as well as increased fat oxidation.

The progression of lung cancer is influenced by the immune system, genetic factors and the inflammatory response.[13] Increased inflammatory response is a component in the development of cancer cells that can be demonstrated through the increase of acute phase proteins (c-reactive protein), so that CRP can be relied as one of the parameters for predicting cancer cell progression and survival rates in patients with various solid cancers.[14]

Research on the intake of carbohydrates, proteins and fats with the development of cancer cells gives inconsistent results.[15-16] Based on the above description, a study about correlation between carbohydrate, protein and fat intake with serum CRP levels as a parameter of cancer cell development in lung cancer patients at Dharmais Cancer Hospital Jakarta was conducted.

Methods

This cross-sectional study was conducted in Dharmais Cancer Hospital Jakarta from March to May 2017. The estimation of minimum sample size was calculated using the formula for a correlation study[17] with a total number of 49 subjects required in this study. Subjects were obtained using consecutive sampling method.

All men and women aged above 18 years old, diagnosed with lung cancer, stage IIIB–IV, currently not receiving any therapy were included in this study. Those who agreed to participate in this study were asked to sign the informed consent. The exclusion criteria were the patients who had chronic liver disease, chronic kidney disease, diabetes mellitus, and after injury.

Data were collected through interviews, anthropometric measurements and blood sampling. Interviews were conducted to determine the characteristics of subjects. Macronutrients intake was obtained by using a semi-quantitative Food Frequency Questionnaire (FFQ). The FFQ was used to estimate the macronutrient usual intake in the past one month. Anthropometric measurements was performed by doing height measurement using *Microtoise Stature Meter* and weight measurement using *SECA® electrodigital* scale. The serum levels of CRP were examined using COBAS C311 using immunoturbidimetric assay.

Data was processed using the program Statistical Package for Social Sciences (SPSS) for Windows version 20. The normality of data distributions was analyzed using Shapiro-Wilk test. If $p<0.05$ data were normal distributed and were presented as mean ± standar deviation, otherwise data were presented as median (minimum-maximum). The correlation of carbohydrate, protein and fat intake with CRP serum were analyzed by Spearman rank collection test.

Results:

Subjects characteristics

The characteristics of the subjects were summarized in Table 1. The mean age of subjects was 55.82 ± 12.26 years old, most of them were men. A total of 67.4% subjects have middle low education level and 79.6% have incomes above the minimum wage. Cancer histopatology were 95.9% non-small cell lung cancer (NSCLC). About 79.6% subjects were in stage IV and 57.1% subjects had smoking history. Nutritional status assessment used body mass index (BMI) parameters based on Asia Pasific classification. There were 36.7% normoweight subjects and 20.4% underweight subjects.

The median energy intake of the subjects were 1740.5 (207.5–2527.9) kcal/day, with 53.1% subjects showed that energy intake still below ESPEN recommendations (30 kcal/kgBW per day). The average carbohydate intake were 59.59 ± 8.11%, with 75.5% subject at range of 45–65% carbohydrate from total energy. Mean protein intake were 63.65 ± 25g per day or 15,53 ± 3,83% of total energy intake. Mean fat intake were 46.57 ± 22.62 g per day or 24.73 ± 6.7% of total energy intake.

Median serum CRP levels were 23.82 mg/L (0.30–207.29 mg/L), with 61.2% of subjects having serum CRP levels > 10mg/L (Table 2)

Table 1 Characteristics of subjects (n=49)

Variabel	Value
Age, (year)	55.82 ± 12.26*
Sex, n (%)	
Men	31 (63.3%)
Women	18 (36.7%)
Education, n (%)	
Low	12 (24.5%)
Middle	21 (42.9%)
High	16 (32.7%)
Income, n (%)	
Below minimum wage	10 (32.7%)
Above minimum wage	39 (79.6%)
Smoking history, n(%)	
Never smoked	21 (42.9%)
Smoking	28 (57.1%)
Body mass index, n (%)	
Underweight	10 (20.4%)
Normoweight	18 (36.7%)
Overweight	10 (20.4%)
Obese 1	7 (14.3%)
Obese 2	4 (8.2%)
Histopatology, n(%)	
NSCLC	47 (95.9%)
SCLC	2 (4.1%)
Stage, n (%)	
III B	10 (20.4%)
IV	39 (79.6%)

*Mean ± standard deviation ** Median (minimum value - maximum)

Table 2 Serum CRP level

Variabel	Value
Serum CRP level, mg/L	23,82 (0,30 - 207,29)**
≤10 mg/L, n(%)	19 (38,8%)
>10 mg/L, n(%)	30 (61,2%)
Stage IIIB	14,46 (0,30-141,17)**
Stage IV	23,82 (1,23 – 207,29)**

** Median (Minimum – Maksimum)

In this study, we did not find significant correlation between carbohydrate, protein and fat intake with serum CRP levels. (Table 3)

Table 3 Correlation between carbohydrate, protein and fat intake with serum CRP levels (n=49)

Variable	Variable Serum CRP	
	r value	p value
Carbohydrate intake to total energy (%)	0.015†	0.919
Protein intake to total energy (%)	-0.165†	0.257
Fat intake to total energy (%)	0.003†	0.986

† Spearman rank correlation test

Discussions

In this study, the number of male subjects were more than women with a ratio of 1.8:1, with average age of the subjects of this study was 55.83 ± 12.62 years. Study by Sutandyo[18] conducted at the Dharmais Cancer Hospital found similar results to the male: female ratio = 3.1:1 and the mean age of the patients were 58 years. A total of 57.1% of subjects in this study had a history of smoking. This is different from the theory that 90% of lung cancer incidence is associated with smoking.[19] This difference may be due to a decrease in the prevalence of smoking and the presence of other risk factors that can cause lung cancer, such as air pollution, prolonged exposure to carcinogenic substances.[19] Based on data of cancer stage distribution, most of research subjects are in stage IV. Similar results were also obtained in the Sanchez-Lara study.[20] This was consistent with the prevalence of advanced lung cancer higher than the early stages. This condition occured because in the early stages, lung cancer often does not show symptoms or showing unspecific symptoms, so lung cancer was diagnosed when the disease has been in an advanced stage.[21]

Median total energy intake of the subjects in this study were 1740.5 (207.5–2527.9) kcal per day or 29.68 ± 10.67 kcal/kgBW per day. A total of 53.1% of subjects showed total energy intake under the recommendation of ESPEN. In this study, 42.9% of subjects were found to have protein intake below 1g/kg BW per day with average protein intake of 63.65 ± 25 g per day or 1.14 g/kg BW per day, obtained by dividing total protein intake per day per subject with actual body weight. Around 57.1% of subjects in this study had low fat intake (<25%) with an average fat intake of 24.73 ± 6.7% of total energy intake per day. A few reasons that can cause low energy intake in cancer patients including the decrease in appetite due to the role of pro-inflammatory cytokines in inhibiting the orexigenic pathway neuropeptide Y and stimulate anorexigenic α-MSH pathway, nausea, satiety and chemosensory disorders such as persistent bad taste in the mouth, taste distortion, and heightened sensitivity to odors that often occurs in patients with advanced cancer.[10,22]

Serum CRP levels can be relied upon as one of the parameters for predicting cancer cell progression in patients with various solid cancers.[14] This study found no correlation between carbohydrate intake to total energy ($p = 0.919$) with serum CRP levels. In contrast to studies conducted by Ho et al[23] using tumor size in mice to assess cancer cell progression, there was a significant positive correlation between low carbohydrate intake (15% of total daily intake) and tumor size ($p < 0.05$). In this study, in addition to using tumor size, insulin levels and lactate levels are also used as a parameter of cancer development. There was positive correlation between low carbohydrate diet with insulin level and lactate level ($p < 0.05$). The difference in outcomes between these two studies may be due to low carbohydrate intake, parameters used to assess tumor progression, type and stage of cancer. Percentage of carbohydrate intake used was 15%, whereas in this study the average carbohydrate intake of the subject was 59.59 $\pm$ 8.11%.

This study has not proved the correlation between protein intake to total energy ($p=0.257$) with serum CRP levels. Similarly, a study conducted by Lima et al[24] found no association between protein intake and serum CRP levels ($p>0.05$) in 30 gastrointestinal cancer patients. The study by Stobaus et al[25] in 285 cancer patients with chemotherapy found that a low protein intake group (<1 g/kg BW) showed a significant difference in mortality ($p = 0.024$) compared with patients from the high protein intake group ($\geq$1 g / kg BW) and low protein intake is associated with fatigue and nausea/vomiting. The results of study conducted by Stobaus et al indicate that protein intake is good for supporting cancer patients.

This study has not proved the correlation between fat intake to total energy with CRP levels ($p=0.986$). In contrast to a study conducted by Fontana et al[15] found a significant association between fat intake and CRP levels ($p<0.027$). In the study of Fontana et al, a significant relationship between fat intake with levels of IGF-1 ($p<0.003$) and leptin levels ($p<0.027$) was also discovered. IGF-1 is mainly regulated by dietary intake to stimulate cell proliferation and inhibit cell death, so IGF-1 can support tumor development.

CRP levels are influenced by many factors.[26-27] Some have been controlled such as acute infection, chronic illness, acute trauma and pregnancy. But there are still those that have not been controlled like allergic complication of infection and inflammatory diseases. Between macronutrients with inflammatory levels in this study using serum CRP level as a marker, chronic inflammatory biomarkers may be more meaningful when associated with intake, since intake is a long-term exposure factor.

In a further stage-based analysis, we did found in stage IV cancer patient there was a negative correlation but not significant between protein intake to total energy and serum CRP levels ($r=-0.293$ and $p=0.070$) as well as fat intake to total energy and serum CRP levels ($r=-0.060$ and $p=0.717$). From these findings, we further research using a larger number of subjects.

In conclusion, the results of this study can not prove that there is a correlation between carbohydrate, protein and fat intake with serum CRP level in lung cancer stage IIIB–IV. Further study regarding the association of macronutrient intake with serum CRP level using equally distributed subjects according to cancer stage is necessary. Early detection on malnutrion and early nutrition therapy, education and counseling are given to patients and their family to prevent malnutrition, which potentially increased morbidity and mortality in advanced cancer patient.

Conflict of Interest

Authors declared no conflict of interest regarding this study.

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References

1. GLOBOCAN. Estimated cancer incidence, mortality and prevalance worldwide in 2012, International Agency for Research on Cancer, World Health Organization 2012. http://globocan.iarc.fr/Pages/fact_sheets_cancer .aspx (accessed 4 October 2016).
2. Komite Nasional Penanggulangan Kanker (KPKN). *Panduan nasional penanganan kanker paru*. Kementerian Kesehatan Republik Indonesia, 2015
3. Santarpia L, Contaldo F, Pasanisi F. Nutritional screening and early treatment of malnutrition in cancer patients. J Cachexia Sarcopenia Muscle 2011;2:27.
4. Ross PJ, Ashley S, Norton A, Priest K, Waters JS, Eisen T, et al. Do patients with weight loss have a worse outcome when undergoing chemotherapy for lung cancers. British journal of cancer 2004 May;90(10):1905–11.
5. Cutsem, E. Van , Arends J. The causes and consequences of cancer-associated malnutrition. European Journal of Oncology Nursing 2005 Dec;9.
6. Balkwill FR, Capasso M, Hagemann T. The tumor microenvironment at a glance. J Cell Sci 2012;135:5591.
7. Beloribi-Djefaflia S, Vasseur S, Guillaumond F. Lipid metabolic reprogramming in cancer cells. Oncsis 2016;5:189.
8. Warburg O, Wind F, Negelein E. The metabolism of tumors in the body. J Gen Physiol 1927;8:519–30.
9. Djiogue S, Kamdje AHN, Vecchio L, Maulilio JK, Farahna M, Aldebasi Y, et al. Insulin resistance and cancer: the role of insulin and IGFs. Endocr Relat Cancer 2013;20.
10. Donohoe CL, Ryan AM, Reynolds JV. . Cancer cachexia: mechanisms and clinical implications. Gastroentral Res Pract 2011; 2011.
11. Porporato PE. Understanding cachexia as a cancer metabolic syndrome. Oncsis 2016;5:e200
12. Lieberman M, Marks AD, Peet A. Carbohydate Metabolism. In: Mark's Basic Medical Biochemistry A Clinical Approach 4th edition. Philadelphia: Lippincott Williams & Wilkins; 2013.
13. Hanahan D, Weinberg RA. Hallmarks of cancer: the next generation. cell 2011 Mar;144(5):646–74.
14. Roxburgh CSD, McMillan DC. Role of systemic inflammatory response in predicting survival in patients with primary operable cancer. Future Oncol 2010;6(1):149.
15. Fontana L, Klein S, Holloszy JO. Long-term low-protein, low-calorie diet and endurance exercise modulate metabolic factors associated with cancer risk. Am J Clin Nutr 2006;84:1456.
16. Freedland SJ, Mavropoulos J, Wang A, Darshan M, Demark-Wahnefried W, et al. Carbohydrate restriction, prostate cancer growth, and the insulin-like growth factor axis. Prostate 2008;68:11.
17. Madiyono B, Moeslichan S, Sastroasmoro S, Budiman I, Purwanto SH. Perkiraan besar sampel. Dalam: Sastroasmoro S, Ismael S, editor. *Dasar-dasar metodologi penelitian klinis*. Edisi ke-4. Jakarta: Sagung Seto 2011;348–81
18. Sutandyo N. Epidemiological data and survival of lung cancer in Indonesia. Dharmais cancer hospital, Indonesia, 2015
19. Alberg AJ, Brock MV, Ford JG, Samet JM, Spivack SD. Epidemiology of lung cancer. Chest 2015;143(5): e1s–e29s
20. Sanchez-Lara K, Turcott JG, Juarez E, Guevara P, Nunez-Valencia C. Association of nutritional parameters including bioelectrical impedance and systemic inflammatory response with quality of life and prognosis in patients with advanced non-small-cell lung cancer: a prospective study. Nutr Cancer 2012;64:526.
21. Perhimpunan Dokter Paru Indonesia. Kanker paru pedoman diagnosis & penatalaksanaan di Indonesia. Edition 2015. Jakarta, Markindo Anugerah Citra Pratama, 2016
22. Hutton JL, Baracos VE, Wismer WV. Chemosensory dysfunction is a primary factor in the evolution of declining nutritional status and quality of life in patients with advanced cancer. J Pain Symptom Manage 2007;33:156.
23. Ho VW, Leung K, Hsu A, Luk B, Lai J, Shen SY, et al. A low carbohydrate, high protein diet slows tumor growth and prevents cancer initiation. Cancer Res 2011;71(13):4484.

24. Kv, d.L. (Gomes) , Maio R. Nutritional Status, systemic inflammation and prognosis of patients with gastrointestinal cancer. Nutr Hosp 2012;27(3):707.
25. Stobaus N, Muller MJ, Kupferling S, Schulzke J, Norman K. Low recent protein intake predicts cancer-related fatigue and increased mortality in patients with advanced tumor disease undergoing chemotherapy. Nutr Cancer 2015;67(5):818.
26. Heikkila K, Ebrahim S, Lawlor DA. A systematic review of the association between circulating concentration of C reactive protein and cancer. J Epidemiol Community Health 2007;61:824.
27. Pepys MB, Hirschfield GM. C-reactive protein: a critical update. J Clin Invest 2003;111:1805.

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ORIGINAL PAPER

Effects of Electrolyte Beverage on Preventing Dehydration Among Workers in Different Enviromental Temperature

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Abstract

Introduction: Water and electrolyte balance is important to maintain cognitive and physical performance, especially in hot environment. This study aimed to evaluate the effects of two different type of fluid intake at the workplace in preventing dehydration among male workers working in a hot and conveniently cool environment.

Methods: This randomized double-blinded placebo controlled trial study was performed in two appointed factories in West-Java in January-February 2012. Seventy-eight healthy male subjects, age 25–45 years old were selected and they were grouped based on their working environmental temperature, i.e. hot and conveniently cool environment. The subjects were randomly allocated by using crossover approach, to have non-electrolyte beverage (plain water) and electrolyte drink in the workplace for 2 days, respectively. Hydration and electrolyte biomarkers were collected from blood and urine samples at before and after the intervention.

Results: At baseline, subjects of the hot environment workplace had higher daily working hours, hemoglobin, hematocrit, blood viscosity, and blood sodium concentration as compared to those of conveniently cool environment ($p<0.05$). After the intervention, for the subjects in hot environment alone, there were significantly lower value of blood viscosity, hemoglobin, and hematocrit, but significantly higher value for blood sodium, USG (urine specific gravity), pH, urinary sodium, urinary potassium and urinary chloride ($p<0.05$), among subjects who had the electrolyte drink compared to the plain water.

Conclusion: This study confirmed that consumption of electrolyte beverage during working in hot environment temperature could help to improve hydration status and electrolyte concentration.

Keywords hydration, electrolyte beverage, hot environment, workers

Introduction

Dehydration is a condition of body water deficit. In general, according to the research by The Indonesian Regional Hydration Study (THIRST) held on 2009, 46.1% of population in Indonesia had mild dehydration.[1] In a physical work setting, dehydration may result from the excessive sweat output compared to the water intake. Hydration in the work place became a special issue in which it can affect productivity, safety, and cost.

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Physical work increases heat production in the body which needs to be dissipated out from the body to achieve body heat balance.[2] In a warm environment, excess of metabolic heat is dissipated to the environment by combination of conduction, convection, radiation, and evaporation of the sweat. When the environmental temperature approaches and exceeds the skin temperature, dry heat loss (by conduction, convection, and radiation) diminishes and is replaced by the 'heat gain'. In that condition, the only available heat loss mechanism is by sweat evaporation, and the sweat rate increases.[3] Severity of sweat losses during work in a hot environment is dependent primarily on work intensity and duration. Sweating draws water from vascular, interstitial, and extra-cellular fluid compartments resulting in the secretion of hypotonic sweat. Metabolic heat production is balanced by both dry and evaporative (sweating) heat loss, but very high metabolic rates coupled with warm weather demands a larger thermal requirement for evaporative cooling, leading to greater sweat losses and subsequently larger water requirement.

It is widely known that water and electrolyte balance is very important to be continuously maintained to sustain cognitive and physical performance. Body water deficit results from hot weather and/or low water consumption, even as much as two percent of body weight, may impair physical and/or work performance. Any water deficit will affect performance in athlete or worker and lead to altered physical function and health. Therefore, an adequate level of hydration is essential. The possibility of water and electrolyte losses through sweating should be put into consideration for people working in hot environments. Electrolyte beverage usually contains water, electrolytes such as sodium, potassium, calcium, and carbohydrate as well. The addition of electrolytes to ingested water will keep the plasma electrolyte concentration and osmolality stable thus the water diuresis can be avoided. Electrolyte beverage has been reported to be more effective in retaining water in the body and preventing hemoconcentration than plain water. Ingestion of plain water will cause voluntary dehydration due to decrease of the osmolality that lead to stimulate the water diuresis. Chang et al.[4] in 2010, reported that the recovery from high blood viscosity induced by dehydration was faster with electrolyte beverage consumption than with plain water or tea. A strong correlation between hematocrit and blood viscosity suggests that fluid retained in the body reduced the hemoconcentration and blood viscosity.[4] In our preliminary study showed that workers in two factories, with different environment which are hot and conveniently cool environment were prone to dehydration. We found that hemoglobin concentration, hematocrit, blood viscosity and blood sodium concentration of workers in hot environment were significantly higher than workers in conveniently cool environment.[5]

This present study was performed to evaluate the effect of electrolyte beverage in preventing dehydration from workers, especially noted from clinical symptoms and laboratory measurements (hemoglobin, hematocrit, blood viscosity, blood and urine minerals, urine specific gravity and pH) and to compare the effects of electrolyte beverage and plain water in preventing dehydration in workers in real work setting. It is very important to prevent worker from dehydration and to protect or reduce the risk of having cardiovascular problem which can be caused by hemoconcentration and high blood viscosity. This study hopefully could give information needed in the occupational field settings with workers who work in a hot and conveniently cool environment, who are considered to be at risk of dehydration that might lower their productivity. Therefore, the management departments may obtain some insights from this research to overcome this problem.

Methods:

Study Design

The study was a crossover, randomized, double-blinded placebo controlled trial involving apparently healthy male subjects workers age 25–45 years old, working minimally for 8 hours per-day in two selected manufactures in Cibitung, West-Java. They did not have renal disease and diabetes mellitus, and willing to participate in the study by signing the informed consent.

We could not find any references on the difference effect of electrolyte drink versus the

drinking water on hydration status and electrolytes concentration. Therefore this study was conducted as a preliminary study to have 40 subjects for each environment condition or minimal 80 subjects for the total sample.

After signing the informed consent, the selected subjects were classified according to their environmental temperature, i.e. the hot and conveniently cool environments, which were determined by room temperature measurement (36–38°C versus 20–22 °C, respectively). Subjects working in hot environment were those working close to the heat. Subjects working in conveniently cool environment were those doing the administration task in the office facilitated with air conditioner. The subjects of each environment temperature were randomly allocated into two different interventions by using crossover approach, in which each subject acted as his own control (Figure 1). Then, each subject will get both interventions for two days period. Subjects were advised to consume 300 mL of the provided fluid every 30 minutes for those working in hot environment and every hour for those working in the conveniently cool environment. Each subject had two days of non-electrolyte beverage (plain water) and, after the crossover, had two days of electrolyte beverage as well. These drinks were provided during 8-hours working period in 4 days of intervention (the subjects can have ad libitum drink), served personally in similar shape and color glasses. The total fluid intake was recorded through measuring the left over drink. During the intervention, lunch and break time snacks were provided with calorie contributing to 30-40% of the total calorie.

Study overview

This study was done at two automobile spare-parts factories in Cibitung West Java in January to February 2012. Before starting the recruitment and including the subjects into the study, informed consent was asked and recorded. This study received ethical approval from the Ethics Committee of the Faculty of Medicine Universitas Indonesia (No. 30/PT02/FK/ETIK/2012, January 18, 2012). All subjects signed the informed consent form to show their willingness to participate in the study.

Data Collection

Subjects were interviewed regarding their socio-demographic characteristic, employment duration and medical history. Interview was needed to clarify the food record as well. Food record method was used to assess energy intake and was done in 4 consecutive days during the intervention period. Anthropometric measurements were done before the intervention, which included body weight and height to calculate the body mass index. Vital sign measurements including blood pressure and heart rates were collected through physical examination.

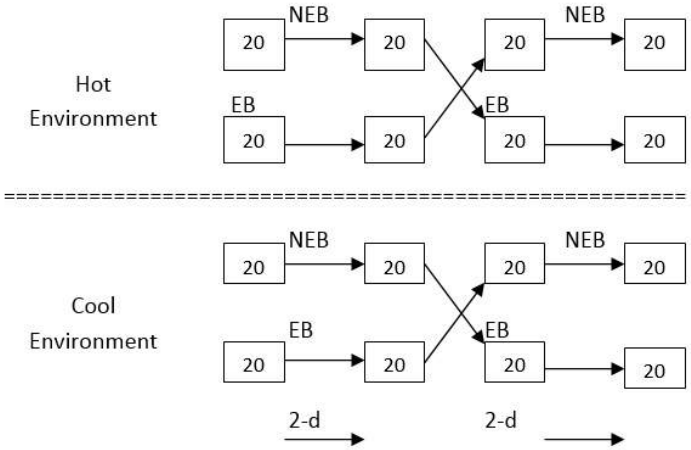

Figure 1
Diagram of study design to see the effect of electrolyte beverage in preventing dehydration among workers in two different environments (EB, electrolyte drink; NEB non-electrolyte drink or plain water)

Blood and urine samples were collected before intervention to obtain baseline data on hemoglobin, hematocrit, blood viscosity, blood glucose, renal function (estimated creatinine-clearance test), blood and urine electrolytes (sodium, potassium and chloride), urine color, pH, and urine specific gravity (USG) by using standardized procedures. The data was collected again after two days after the working time during the four days study period to obtain data on the effect of each of the intervention.

Statistical Analyses

Data was recorded using a special form and was edited, coded, and administered into the working sheet by using statistical program for social sciences (SPSS) software version 20. All data was presented accordingly based on its normality distribution, and analyzed by using unpaired-T test or Mann-Whitney test, paired-T test or Wilcoxon test, and Chi-square or McNemar test.

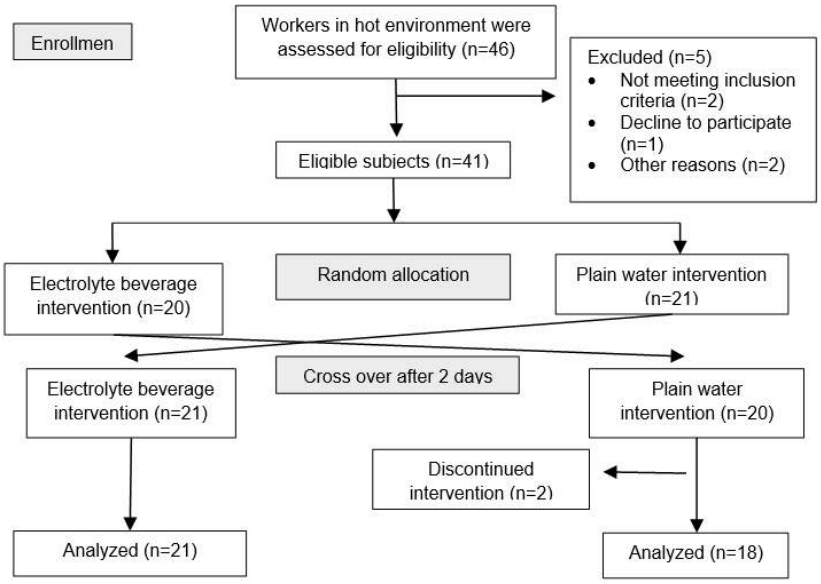

Figure 2A
Flow diagram of subjects in hot environment workplace

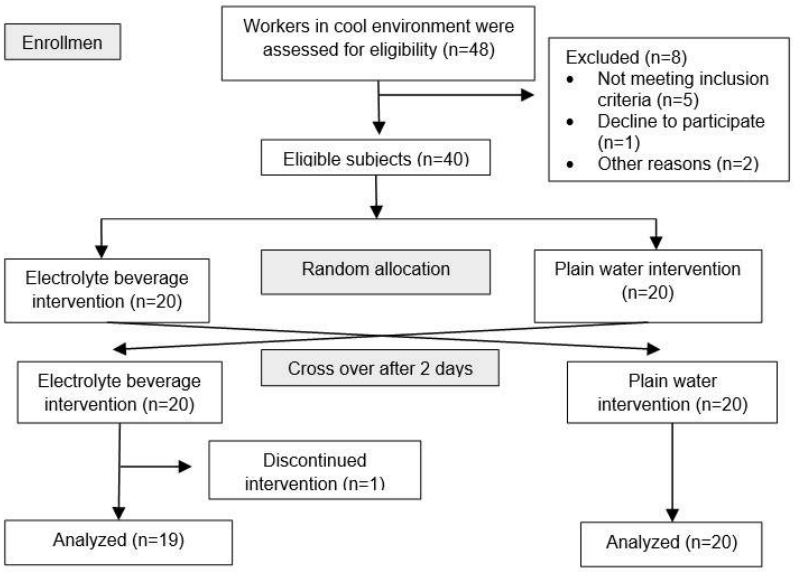

Figure 2B
Flow diagram of subjects in conveniently cool environment workplace

Results

The recruitment of the subjects started from 6th January 2012 and ended on 3rd February 2012. Figure 2A and Figure 2B show the flow of the intervention and data collection scheme, and we analyzed 39 subjects receiving both interventions in each workplace conditions, i.e. hot and conveniently cool environment.

Before the intervention, this study found that there were significant differences in several hydration and electrolytes biomarkers, in which hemoglobin, hematocrit, blood viscosity and blood sodium were higher among those working in hot environment compared to those working in the conveniently cool environment workplace ($P<0.05$), as shown in Table 1. The general conditions of the subjects in both temperature workplaces were not affected by the interventions, as presented in Table 2.

In the blood measurement, there were significant lower values of blood viscosity, hemoglobin, hematocrit, and blood sodium concentration among subjects after receiving electrolyte drink compared to subjects receiving plain water for two days, but only among those working in hot environment workplace, as shown in Table 3.

However, Table 4 shows that those having electrolyte drink had significantly higher USG, pH, urinary sodium, potassium and chloride compared to those having plain water in which, again, only found among those working in hot environment workplace.

Table 1 General characteristics of the subjects by different workplace environment before interventions

Variables	Hot environment	Cool environment	P-value
Age, y	29 (25–44)^	30 (25–45)^	0.086*
Duration of working, y	8 (1–22)^	8 (1–30)^	0.695*
Working hours/day	12 (8–12) ^	8 (7–12) ^	<0.001*
Body weight, kg	64.81±11.9~	68.97±12.0~	0.129**
Body height, m	1.67 (1.55–1.87) ^	1.66 (1.57–1.83) ^	0.682*
BMI, kg/m^2	23.6±4.8~	24.8±4.2~	0.227**
Hemoglobin, g/dL	15.6 (12.3–18.0)^	14.8 (12.6–17.2)^	**0.017***
Hematocrit, %	46 (39– 49)^	44 (40–49)^	**0.040***
Blood viscosity, mPa.s	23.0±8.2~	12.0±2.2~	**<0.001****
Blood sodium, mOsm/L	140 (136–145)^	138 (135–141)^	**<0.001***
USG	1.0178±0.0076~	1.0187±0.0077~	0.626**
Blood pressure, mmHg:			
Systolic	110 (90–160)^	120 (80–150)^	0.243*
Diastolic	80 (60–100)^	80 (60–100)^	0.949*

BMI, body mass index; USG, urine specific ^median (minimum-maximum); ~mean (SD),

*Mann-Whitney test; **unpaired-t test

Table 2 General conditions of the subjects by beverage-drink type intake in different workplace environments

General Conditions	Hot-environment			Cool-environment		
	Plain water	Electrolyte drink	P-value	Plain water	Electrolyte drink	P-value
Systolic BP (mmHg)						
Baseline	120 (100– 140)^	110 (90–160)^	0.907*	110 (80–140)^	120 (90–150)^	0.817*
After two days	120 (100–150)^	120 (100–150)^	0.683*	110 (100–150)^	120 (100–150)^	0.161*
Diastolic BP (mmHg):						
Baseline	80 (60–90)^	80 (60–100)^	0.861*	70 (60–100)^	80 (60–100)^	0.238*
After two days	80 (70–100)^	80 (60–90)^	0.397*	80 (60–100)^	80 (60–100)^	0.285*
Heart rate (times/minute):						
Baseline	72 (60–88)^	72±6~	0.900*	78±7~	72±7~	0.706**
After two days	78 (60–84)^	78 (66 –84)^	0.408*	73±8~	74±8~	0.498**
Fluid intake (mL):						
Baseline	3732.8±745.9~	3640.0±666.4~	0.219**	1785.5±489.0~	1805.3±459.7~	0.781**
After two days	3813.6±6653.4~	4059 (1660–4800)^	0.159*	1749±518.0~	1778±492.9~	0.698**

^median (minimum-maximum); ~mean (SD), *Wilcoxon test; **paired-t test

Table 3 Hydration biomarkers of the subjects taken from blood sample by beverage-drink type intake in different workplace environments

Hydration biomarkers	**Hot-environment**			**Cool-environment**		
	Plain water	**Electrolyte drink**	**P-value**	**Plain water**	**Electrolyte drink**	**P-value**
Viscosity (mPa.s):						
Baseline	16.6 (8.3–36.9)^	15.0 (7.4–39.2)^	0.685*	12.1±2.3~	12.1±2.0~	0.939**
After two days	12.6 (7.4–29.0)^	12.2±2.6~	**0.013***	11.6±2.0~	12.1±2.5~	0.146**
Changes after – baseline	-2.0 (-16.0–3.1)^	-4.1 (-22.1–1.1)^	0.277*	-0.5±2.4~	0.05±2.3~	0.371**
Hemoglobin (mg/dL):						
Baseline	14.9±1.1~	15.0±1.1~	0.455**	14.8 (13.0–16.3)^	14.7±0.9~	0.928*
After two days	14.8±1.1~	14.4±1.0~	**0.001****	14.5±0.7~	14.7±0.7~	0.060**
Changes after – baseline	-0.1±0.8~	-0.4 (-2.0–0.8)^	0.088*	-0.2±0.5~	-0.1±0.6~	0.295**

Table 3 (continued)

Hydration biomarkers	**Hot-environment**			**Cool-environment**		
	Plain water	**Electrolyte drink**	**P-value**	**Plain water**	**Electrolyte drink**	**P-value**
Hematocrit (%):						
Baseline	44.5±2.8~	45.0 (38–49)^	0.571*	44 (39–48)^	44 (40–49)^	0.958*
After two days	44.3±2.6~	43.7±2.2~	**0.029****	43 (41–48)^	44 (39–50)^	0.167*
Changes after – baseline	-0.2±2.3~	-1.0 (-5–3.0)^	0.118*	0 (-4–3.0)^	-0.1±2.0~	0.478*
Sodium (mOsm/L):						
Baseline	141.2±1.9~	141.0 (136–145)^	0.663*	139 (137–141)^	138 (135–141)^	0.078*
After two days	141.0 (136–143)^	141.0 (138–146)^	**0.024***	139 (136–140)^	139 (137–141)^	0.114*
Changes after – baseline	-1.0 (-4.0–3.0)^	0 (-3.0–6.0)^	90*	0 (-3.0–3.0)^	0 (-3.0–6.0)^	0.051*
Potassium (mOsm/L):						
Baseline	4.0 (3.4–5.0)^	4.0 (3.4–5.0)^	0.468*	4.0 (3.6–6.0)^	4.0 (3.5–5.0)^	0.496*
After two days	4.0 (3.2–4.4)^	4.0 (3.4–5.0)^	0.671*	3.8 (3.4–4.4)^	3.9 (3.3–4.5)^	0.423*
Changes after – baseline	0 (-1.6–0.4)^	0 (-1.0–1.0)^	0.396*	-0.3 (-1.9–0.4)^	-0.3 (-1.3–0.5)^	0.209*

Table 3 (continued)

Hydration biomarkers	**Hot-environment**			**Cool-environment**		
	Plain water	**Electrolyte drink**	**P-value**	**Plain water**	**Electrolyte drink**	**P-value**
Chloride (mOsm/L):						
Baseline	101.0 (97–105)^	101.0 (98–104)^	0.937*	102 (100–107)^	102 (99–106)^	0.342*
After two days	100.0 (97–105)^	101.0 (97–105)^	0.185*	102 (100–105)^	102 (100–106)^	0.483*
Changes after – baseline	-0.2±1.8~	0 (-4.0–4.0)^	0.686*	0 (-4.0–3.0)~	0 (-3.0–3.0)~	0.977*

^median (minimum-maximum); ~mean (SD), *Wilcoxon test; **paired-t test

Table 4 Hydration biomarkers of the subjects taken from urine sample by beverage-drink type intake in different workplace environments

Hydration biomarkers	**Hot-environment**			**Cool-environment**		
(from urine-sample)	**Plain water**	**Electrolyte drink**	**P-value**	**Plain water**	**Electrolyte drink**	**P-value**
USG status:						
Baseline	1.009 (1.001–1.033)^	1.014±0.009~	0.451*	1.009 (1.003–1.032)^	1.015±0.007~	0.207*
After two days	1.004 (1.001–1.022)^	1.006 (1.001–1.032)^	**<0.001***	1.006 (1.002–1.029)^	1.007 (1.003–1.026)^	0.401*
Changes after – baseline	-0.007 ±0.010~	-0.003 ±0.010~	0.115**	-0.005 ±0.010~	-0.007 ±0.008~	0.454**

Table 4 (continued)

Hydration biomarkers	**Hot-environment**			**Cool-environment**		
(from urine-sample)	**Plain water**	**Electrolyte drink**	**P-value**	**Plain water**	**Electrolyte drink**	**P-value**
pH:						
Baseline	6 (5–7)^	6 (5–7)^	0.123*	6 (5–7)^	6.5 (5–8)^	0.664*
After two days	6 (5–7)^	6 (5–8)^	**0.003***	6 (5–7)^	6 (5–7)^	0.293*
Changes after – baseline	0 (-1.0–1.0)^	0 (-1.0–2.0)^	**0.003***	0 (-2.0–2.0)^	0.2±0.8~	0.947*
Normal urine color, n(%):						
Baseline	32 (82.1)	35 (89.7)	0.549***	35 (89.7)	33 (84.6)	0.727***
After two days	39 (100)	36 (92.3)	-	39 (100)	39 (100)	-
Sodium (mOsm/L):						
Baseline	64 (14–232)^	95 (10 - 256)^	0.553*	70.8 (0–299.0)^	94.0 (30.0–266.3)^	0.379*
After two days	29.8 (13.0–143.8)^	62 (13–301)^	**<0.001***	41.0 (13.1–180.6)^	50.4 (15.3–194.1)^	0.426*
Changes after – baseline	-41.0 (-192.0–104.7)^	3.2±94.4~	0.054*	-13.7 (-281.5–103.6)^	-36.4 (-244.5–97.4)^	0.577*

Table 4 (continued)

Hydration biomarkers	**Hot-environment**			**Cool-environment**		
(from urine-sample)	**Plain water**	**Electrolyte drink**	**P-value**	**Plain water**	**Electrolyte drink**	**P-value**
Potassium (mOsm/L):						
Baseline	16.0 (1.0–97.2)^	20.0 (2.0–93.0)^	0.942*	15.0 (0–110.5)^	23.7 (4.4–109.0)^	0.302*
After two days	6.0 (1.0 – 51.2)^	11.0 (1.0–94.5)^	**<0.001***	8.5 (2.5–46.0)^	9.4 (3.2–73.3)^	0.384*
Changes after – baseline	-7.0 (-71.0–18.0)^	-1.0 (-92.0–74.5)^	0.246*	-2.8 (-79.4–20.0)^	-13.2 (-86.4–11.8)^	0.468*
Chloride (mOsm/L):						
Baseline	65.0 (7.1–356.0)^	116.4±84.8~	0.577*	27.6 (0–199.1)^	122.3±75.4~	**<0.001***
After two days	23.0 (7.0–146.7)^	100.0 (10.0–274.3)^	**<0.001***	35.2 (8.5–167.3)^	45.4 (10.5–177.7)^	0.276*
Changes after – baseline	-31.0 (-283.0–118.5)^	-25.7±114.5~	0.161*	5.4 (-78.4–128.5)^	-41.7 (-247.2–94.6)^	**<0.001***

^median (minimum-maximum); ~mean (SD),
*Wilcoxon test; **paired-t test; ***McNemar-test

Discussion

This study aimed to evaluate the effect of electrolyte beverage in preventing dehydration for workers, especially noted from clinical symptoms and laboratory measurements (hemoglobin, hematocrit, blood viscosity, blood and urine minerals, urine specific gravity and pH). This study's objective was also to compare the effect of electrolyte beverage and plain water (non-electrolyte drink) in promoting hydration and electrolytes balance among the workers in hot and conveniently cool environment. We tried to keep the subjects as stated in the protocol of the study, however, two subjects from the hot environment and one subject from the cool environment had to leave due to urgent reasonable reasons (Figure 2A and Figure 2B).

Based on work environment difference, the subjects had similar age, however they had different working hours (Table 1). It was shown that subjects working in the hot environment had significantly longer working hours compared to those working in the cool environment. By working in a hot environment for a longer period, the risk to become dehydrated is higher unless the workers are used to drinking sufficiently. If we could extrapolate by using an example of very active fire fighters, then they should have daily water requirements of about 7 L/day.[6]

Based on the blood analyses, Table 1 shows several indices of hydration status. There were significantly higher hemoglobin concentration, hematocrit, blood viscosity and blood sodium among subjects working in hot environment compared to the subject working in the cool environment. Particularly, 79.5% of subjects working in hot environment had high blood viscosity compared to subjects in the cool environment (25.6%). These showed that workers who work in the hot environment are at higher risk of falling into a dehydration state compared to those working in the conveniently cool environment. The sweating process involves the fluid loss from the extracellular compartment including fluid from the vascular. Hematocrit can be described as relationship between the cellular volume compared to total blood volume. Its level increases when the total RBC amount increases or when a person losses fluid which leads to a decrease of plasma volume, which happens in sweating process. Working in a hot environment increases sweat rates which results in decrease of plasma volume. The blood viscosity increases along with the increasing hematocrit.[7]

The most widely investigated are body mass changes, blood indices, urine indices and bioelectrical impedance analysis.[8] Measurement of haemoglobin concentration and hematocrit has the potential to be used as a marker or change in hydration status. However, Armstrong et al[9] (1994) stated that hematologic measurements are not as sensitive to mild hypohydration as the certain urinary indices. This perhaps suggests that plasma volume is defended in an attempt to maintain cardiovascular stability, and so plasma variables will not be affected by hypohydration or dehydration until a certain degree of body water loss has occurred.

The subjects working in hot environment had higher sodium level than those working in cool environment. This higher levels of sodium is probably caused by two things: first, the water loss from the skin from sweating process made extracellular fluid depletion more excessive in the subjects working in hot environment. Second, the lower water intake of the subjects in hot environment might be the cause of this higher sodium level, which is shown at Tabel 2. As a primary cation in extracellular fluid (ECF), any loss of water will increase sodium concentration in ECF compartment, which in turn will increase plasma osmolality. Plasma osmolality also provides as a marker of dehydration level because it is closely controlled by homeostatic system, thus serving as a primary physiological signal to regulate water balance, i.e. changes in urine output and fluid intake.[10-11]

Plasma or serum sodium concentration and osmolality will increase when the water loss inducing dehydration is hypotonic with respect to plasma. An increase in these concentrations would be expected, as in many cases of hypohydration, including water loss by sweat secretion, urine production or diarrhea. Similar finding was reported by Armstrong et al[9] (1994), which perhaps suggests that plasma volume is defended in an attempt to maintain cardiovascular stability. Thus,

plasma variables will not be affected by dehydration until a certain degree of body water loss has occurred.

Baseline fluid intake (plain water and electrolyte beverage) in both groups, as seen in Table 2, are not significantly different. However, subjects working in hot environment had higher daily fluid requirements compared to subjects in cool environment, because the skin water loss is higher as well and this condition will increase the feeling of thirst. The lower water intake of subjects in hot environment is probably related to water provision. The water supply for workers in hot environment was only provided in a rest area which probably cannot be easily accessed by workers because they could not leave their work at any time and they were not provided with a water container at their work place. On the days of intervention, the median of water intake reached up to 3607–4142 mL. During the interventions, the fluid intake was increase because the researchers provided the water in tumblers which were held in a carrying bag which then easily accessed and drank by the workers. As expected, the amounts of fluid consumptions during the intervention period were significantly higher among workers in the hot environment compared to those working in the cool environment. By providing the fluid at the workplace and giving easy access to the fluid supply, the workers in the hot environment voluntarily increased their fluid consumption which then significantly increased their total fluid intake.

By providing different types of fluid drink, i.e. plain water and isotonic drink, this study showed perceptual factor in relation to voluntary drinking. As widely known, voluntary drinking of a beverage is affected by its palatability, which is determined by its color, flavor, odor, and temperature.[12-17] The sweet flavour of a drink is a major factor in its palatability. However, in reality, people's prefer flavor differ, which depends on various factors, including ethnicity and cultural backgrounds. In this study, it was revealed that there was no difference in the volume of fluid intake between the two different types of provided drink ($p>0.05$) both in the hot and cool environment workers (Table 2).

As seen in Table 2, there was no significant change neither in systolic nor diastolic blood pressure during the intervention in both environment. Intervention with plain water and isotonic fluid both could maintain the blood presssure in a stable condition. Dehydration will typically lower blood pressure slightly due to lower blood volume but this happens only in extreme cases. Extreme overhydration (faster than can be processed and expelled from the body) can lead to a raised blood pressure. The body regulates hormones to keep the blood pressure basically stable except in extreme cases.[18]

Heart rate is a *vital sign* to provide clues to the presence of many medical conditions. Reflex changes in heart rate are one of the body's most basic mechanisms for maintaining proper perfusion to the brain and other tissues.[19] Perfusion is the flow of blood through an organ. Low blood volume caused by bleeding or dehydration results in the heart beating faster as it attempts to maintain adequate blood pressure. Excitement, stress, and anxiety activate the nervous system, which may also speed the heart rate and raise blood pressure. Total body water by weight was found to be related to diastolic blood pressure, $r= -0.56$, $p=0.01$.[18]

Table 3 shows that blood viscosity after intervention is significantly decreased for subjects in hot environment because they were potentially dehydrated induced by the high sweat rates. The isotonic drink had a lower effect on blood viscosity than the plain water as the isotonic drink contains electrolytes which pertains the plasma volume and avoids water diuresis. Hemoglobin and hematocrit were different after the intervention on both groups. However, there was no significant difference between the workers that drink plain water and electrolyte beverage. The lower hematocrit level during intervention suggested more liquid entering the intravascular space which then lowered the hematocrit level, in accordance to the relationship between the cellular volume to the total blood volume.[7] These findings remarked that fluid replacement, either with isotonic drink or plain water, could avoid the potential hemoconcentration during work. While the average blood sodium level of subjects in hot environment during intervention period was significantly different between plain water and electrolyte beverage in hot environment workers, it is not the same in cool convenient environment.

Both interventions lowered the urine specific gravity in hot environment setting as the fluids diluted the urine (Table 4). The administration of isotonic drink first will produce lower urine specific gravity because it retained more fluid in the body. While in the cool environment setting, both interventions lowered the urine specific gravity but there was no difference between the plain water and electrolyte beverage as there were no fluid losses in this setting. The administration of both fluids in subjects of hot environment setting would lower the renal sodium excretion on the first phase, then the isotonic drink on the second phase would made an adequate level in the blood thus excreting more sodium in the urine. In the conveniently cool setting both intervention lowered the renal sodium excretion but no difference between the both fluid. In that setting the isotonic drink gave no benefit physiologically. Plain water and isotonic beverage both could maintain the body water of the subjects in hot environment, as both could replace the increasing water loss from sweating process. In the cool environment, the baseline body water, which was lower than the counterpart, increased after the administration of both fluids, but their peak were more prominent after the administration of isotonic fluid.

In conclusion consuming electrolyte beverage would prevent male workers aged 25–45 years, especially those working in a hot environment from dehydration as compared to non-electrolyte beverage.

Conflict of Interest

Saptawati Bardosono is a one of editors but was not involved in the review or decision process for this article.

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References

1. Hardinsyah, Briawan D, Effendi, YH, Dwiriani CM, Dewi M, Damayanti E, Aries M 2010, Kebiasaan minum dan dan status hidrasi pada remaja dan dewasa di dua wilayah ekologi berbeda, Tim THIRST (The Indonesian Regional Hydration Study), FEMA IPB, FKM UNAIR dan FKM UNHAS, Jakarta.
2. Sawka MN, Montain SJ, Latzka WA. Hydration effects on thermoregulation and performance in the heat. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology 2001 Apr;128(4):679–90. [Google Scholar]
3. Miller VS, Bates GP. Hydration, hydration, hydration. Annals of occupational hygiene 2009;54(2):134–6. [Google Scholar]
4. Chang CQ, Chen YB, Chen ZM, Zhang LT. Effects of a carbohydrate-electrolyte beverage on blood viscosity after dehydration in healthy adults. Chinese medical journal 2010;123(22):3220–5. [Google Scholar]
5. Bardosono S, Ilyas E. Health, nutrition and hydration status of Indonesian workers: a preliminary study in two different environmental settings. Medical Journal of Indonesia 2014;23(2):112. [Google Scholar]
6. Ruby BC, Shriver TC, Zderic TW, Sharkey BJ, Burks C, Tysk S. Total energy expenditure during arduous wildfire suppression. Medicine and Science in Sports and Exercise 2002;34(6):1048–54. [Google Scholar]
7. Karsheva M, Dinkova P, Pentchev I, Ivanova T. Blood rheology-a key for blood circulation in human body. Journal of the University of Chemical Technology and Metallurgy 2009;44(1):50–4. [Google Scholar]

8. Shirreffs SM. Markers of hydration status. European journal of clinical nutrition 2003 Dec;57. [Google Scholar]
9. Armstrong LE, Maresh CM, Castellani JW, Bergeron MF, Kenefick RW, LaGasse KE, et al. Urinary indices of hydration status. International journal of sport nutrition 1994;4(3):265–79. [Google Scholar]
10. Andreoli TE, Reeves WB, Bichet DG 2000, Endocrin control of water balance, in Fray JCS, Goodman HM (ed.), Handbook of Physiology: Endocrin regulation of water and electrolyte balance, Oxford University Press, New York, pp. 530–569.
11. Knepper MA, Valtin H, Sands JM 2000, Renal actions of vasopressin, in Fray JC, Goodman HM(ed.), Handbook of Physiology: Endocrin regulation of water and electrolyte balance, Oxford University Press, New York, pp. 496–529.
12. Boulze D, Montastruc P, Cabanac M. Water intake, pleasure and water temperature in humans. Physiology & behavior 1983;30(1):97-102. [Google Scholar]
13. Hubbard RW, Sandick BL, Matthew WT, Francesconi RP, Sampson JB, Durkot MJ, et al. Voluntary dehydration and alliesthesia for water. Journal of Applied Physiology 1984;57(3):868–73. [Google Scholar]
14. Meyer F, Bar-Or O, Salsberg A, Passe D. Hypohydration during exercise in children: effect on thirst, drink preferences, and rehydration. International Journal of Sport Nutrition 1994;4(1):22–35. [Google Scholar]
15. Szlyk PC, Sils IV, Francesconi RP, Hubbard RW, Armstrong LE. Effects of water temperature and flavoring on voluntary dehydration in men. Physiology & behavior 1989;45(3):639–47. [Google Scholar]
16. Wilk B, Bar-Or O. Effect of drink flavor and NaCl on voluntary drinking and hydration in boys exercising in the heat. Journal of Applied Physiology 1996;80(4):1112–7. [Google Scholar]
17. Zellner DA, Bartoli AM, Eckard R. Influence of color on odor identification and liking ratings. The American journal of psychology. 1991 Dec 1:547–61.
18. Musini VM, Wright JM. Factors affecting blood pressure variability: lessons learned from two systematic reviews of randomized controlled trials. PLoS One. 2009 May 22;4(5):e5673.
19. Suhr JA, Patterson SM, Austin AW, Heffner KL. The relation of hydration status to declarative memory and working memory in older adults. J Nutr Health Aging 2010;14(10):840–3. [Google Scholar]
20. Karsheva M, Dinkova P, Pentchev I, Ivanova T. Blood Rheology - A Key for Blood Circulation in The Human Body. Journal of The University of Chemical Technology and Metallurgy 2009;44(1):50–4. [Google Scholar]

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ORIGINAL PAPER

Macronutrient Intake and Life Style Factors Associated to HbA1c Status in Type-2 Diabetic Patients

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Abstract

Background: This study aims to determine the relationship between macronutrients intake and lifestyle factors to HbA1c status of type-2 diabetic patients in improving the effectiveness of patient's nutritional support therapy and preventing diabetic complications.
Methods: Type-2 diabetic patients were categorized into 2 groups, i.e. patients with good glycemic control with HbA1c < 7.0 and patients with poor glycemic control with HbA1c ≥ 7.0. Data collection included clinical characteristics (i.e. age, gender, body mass index, duration of illness, type and amount of diabetic medication, and diabetic complication). Macronutrient intake consisted of total daily calories and carbohydrate, protein, fat and fiber intakes, whilelifestyle factors consisted of the adherence to dietary advice and medication, physical activities, smoking habit, and alcohol intake. The relationships between all data to HbA1c status were analyzed using Chi Square test.
Results: Younger type-2diabetic patients (<55 years old), carbohydrate intake, and adherence to dietary advice had statistically significant in related to HbA1c status ($p<0.05$).
Conclusions: Health and nutrition education should be provided to the younger age of type-2diabetic patients to maintain proper dietary pattern following to medical nutrition therapy.

Keywords HbA1c status,lifestyle,macronutrient intake

Introduction

Approximately 90% of worldwide Diabetes Mellitus (DM) patients are havingtype-2 Diabetes Mellitus (T2DM). Diabetes Mellitus has become an epidemic in recent years. In year 2000, around 150 millions people in the world suffered from DM, and it was estimated to reach 300 millions in the year 2025. Developing countries in Asia, South America, and Africa are expected to have the biggest increase in T2DM patients.[1,2] Based on data from Health Research and Development of Indonesia Ministry of Health the prevalence of T2DM patients and impaired glucose tolerant patients in Indonesia in 2008 is 5.7% and 10.25%, respectively. By 2020, the prevalence of T2DM patients in Indonesia is estimated to be 8.2 millions of 178 millions citizen with age above 20 years old.[3]

Numerous extensive clinical studies demonstrate that strict control of blood glucose level correlates with the reduction of micro-

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vascular complication risk. American Diabetes Association (ADA) and American Association of Clinical Endocrinologist (AACE) have set a target of HbA1c less than 6.5% as the optimum glycemic control. Despite the evidence of various studies which reveal the benefits of intensive treatment to reduce the risk of micro- and macro-vascular complications for diabetic patients, the number of patients with poor glycemic control remains high. T2DM patients with poor glycemic control are becoming apublic health issue because they have higher risk to develop diabetes complications in the future.[4,5] For Indonesian, the Indonesian Society of Endocrinologist (*Perkumpulan Endokrinologi Indonesia*/ PERKENI) has set a target for HbA1c less than 7.0% as the optimum glycemic control.[6]

Glycemic control is still one of the therapeutic target to prevent major organ damage and other complications for DM patients. During clinical treatment, it is difficult to reach optimum glycemic level in a long-term basis for T2DM patients due to complex reasons. The main reason for poor glycemic control is DM patients' low understanding on the long-term dietary benefits. Results from cross-sectional studies indicate low compliance to dietary recommendation which includes macronutrient intake and fruit and vegetable consumption.[7] Hu et al[8] followed 84.941 female nurses between year 1980 and 1996 (The Nurses' Health Study) and concluded that obesity was the major important predictor of diabetes, while lack of exercises, poor diet, smoking habit, and alcohol intake were also associated with the risk increase in developing diabetes. Rawal et al[9] examined nine publications about the prevention of T2DM and its complications which were conducted in developing countries. The studies concluded that non-pharmacological intervention and lifestyle change were found to be effective in reducing the risk of developing T2DM in patients with impaired glucose tolerance and improving the glycemic control of T2DM patients. This study was done to determine the relationship between macronutrient intake and lifestyle factors to HbA1c status of type-2 diabetic patients who attended Diabetes Clinic in Husada Hospital Jakarta, Indonesia.

Methods

This is a cross sectional study that recruited type-2 diabetic patients who attended Diabetes Clinic in Husada Hospital Jakarta between April to May 2015 by consecutive sampling. The eligibility criteria including over 18 years old, male or female T2DM patients who had medical nutrient therapy for minimum three months, and willing to participate in the study. Patients who were pregnant, breastfeeding mother, had moderate or severe anemia, and/or unable to stand or walk were excluded. All subjects had given informed consent to participate in the study. Sample size was determined by using rule of thumb in analyzing difference in two proportions by having a minimal total sample of 40 subjects.

Approval from the Ethics Committee of Faculty Medicine of University of Indonesia was released before conducting the data collection. Individual interview was held to collect age, gender, the duration of illness, type and amount of diabetic medications, other diabetic complications, and physical activities data. Macronutrient intake pattern (total daily calories and carbohydrate, protein, fat and fiber intake) of at least 1 month were analyzed using semi-quantitative Food Frequency Questionnaire (FFQ). Lifestyle data were collected to assess the adherence to medicine intake, smoking habit, and alcohol intake using 1x 24-hour food recall. Food intake information was disaggregated, converted, and averaged into daily nutrient intake using a computer analysis program called Nutrisurvey 2007. Body mass index (BMI) was calculated as weight in kilograms (SECA scale) divided by the square of height in meters (Microtoise stature meter), the result was then categorized according to Asia-Pacific BMI classification. Glycemic control of HbA1c was analyzed using high performance liquid chromatography, D-10, and the hemoglobin using flow-cytometry (Sysmex).

All statistical analyses were performed using SPSS software package version 20 program. All categorical data were presented as proportions. Chi Square test was used to examine the relationship between macronutrient composition intake and lifestyle factors to HbA1c status. A p-value of <0.05 was considered as statistically significant.

Results:

Clinical Characteristics

This study included 57 T2DM patients whose age between 40 to 79 years old, with median age of 55 years old, median BMI of 26.9 kg/m2 (19.0–45.4), median duration of illness of 5 years (1–30 years), and mean (SD) of haemoglobin of 12.8±1.3 g/dl.

Among all clinical characteristics variables studied, i.e. age, gender, BMI, duration of illness, type and amount of diabetic medication consumed, and other diabetic complications, only age was significantly related to HbA1c (p-value=0.012, see Table 1). This study shows that subjects less than 55 years old had a significantly poor glycemic control (Hb1Ac ≥7.0) compared to those among older age.

Macronutrient intake

Table 2 shows that approximately 10% of the subjects had high daily calorie intake compared to the PERKENI recommendation.This condition can be related to the high proportion of subjects had high fat intake. However, only carbohydrate intake that significantly associated to HbA1c status, in which high carbohydrate intake was only found among those with poor glycemic control (p-value=0.032). PERKENI macronutrient ratio recommendation are carbohydrate 45–65%, protein 10–20%, and lipid 20–25%[6].

Table 1 Clinical characteristics of study subjects and HbA1c status

Clinical Characteristics	Frequency (%)	HbA1c status		P-value
		<7.0 (n=26)	≥7.0 (n=31)	(chi-square test)
Age, years				
18–55	29 (50.8)	8	21	**0.012**
>55	28 (49.2)	18	10	
Gender				
Male	11 (19.3)	6	5	0.745
Female	46 (80.7)	20	26	
BMI, kg/m^2				
<18.5	-	-	-	
18.5–22.9	11 (19.3)	4	7	0.727
23–24.9	14 (24.6)	8	6	
25–29.9	15 (26.3)	9	6	
≥30	17 (29.8)	5	12	
Duration of diabetes				
<5	28 (49.2)	16	12	0.147
≥5	29 (50.8)	10	19	
Diabetes treatment				
None	3 (5.3)	3	-	0.792
OHO	49 (85,9)	21	28	
Insulin	3 (5.3)	1	2	
Combination	2 (3.5	1	1	
Amount of diabetic medicine				
None	3 (5.3)	3	-	0.169
1	21 (36.8)	11	10	
>1	33 (57.9)	12	21	
Diabetic complication				
None	6 (10.5)	3	3	0.576
Yes	51 (89.5)	23	28	

Table 2 Macronutrient intake of study subject and HbA1c status

Macronutrient intake	Frequency (%)	HbA1c status		P value (chi-square test)
		<7.0 (n=26)	≥7.0 (n=31)	
Daily calorie intake, % the recommendation				
<90	26 (45.6)	11	15	0.523
90–110	25 (43.8)	13	12	
>110	6 (10.6)	2	4	
Carbohydrate (C), % total calorie				
<45	15 (26.3)	8	6	0.032
45–60	37 (64.9)	18	20	
>60	5 (8.8)	-	5	
Protein (P), % total calorie				
<10	-	-	-	0.499
10–20	52 (91.2)	23	29	
>20	5 (8.8)	3	2	
Fat (F), % total calorie				
<20	1 (1.8)	-	1	0.103
20–25	2 (3.5)	-	2	
>25	54 (94.7)	26	28	
Fiber, g				0.187
<20	2 (3.5)	-	2	
20–25	21 (36.8)	7	14	
>25	34 (59.7)	19	15	
C, P, F ratio, % total calorie		47:18:35	51:16:33	

Lifestyle

Approximately 54.4% subjects had good adherence to dietary advice and performed light activities, while 86% subjects had good adherence to medication, only 7% were active smokers, and none were consuming alcohol.

Physical activity categories were based on Compedium of Physical Activities (light MET <3, moderate MET 3–6, heavy MET>6).[10] Table 3 shows a significant relationship between adherence to diet and HbA1c status (p-value=0.004), in which those not adhered to diet had higher proportion of poor glycemic control.

Table 3 Life style of study subjects and HbA1c status

Life style Characteristics	Frequency (%)	HbA1c status		P value (chi-square test)
		<7.0 (n=26)	≥7.0 (n=31)	
Adherence to diet				
Yes	31 (54.4)	20	11	**0.004**
No	26 (44.6)	6	20	
Physical activity				
Light (MET <3)	31 (44.6)	12	19	0.381
Moderate/heavy (MET >3)	26 (54.4)	14	12	
Adherence to medication				
Yes	49 (85.9)	22	27	0.142
Not taking it	3 (5.3)	3	-	
No	5 (8.8)	1	4	
Smoking				
Yes	4 (7.0)	1	3	0.376
No	53 (93.0)	25	28	

MET: metabolic equivalent

Discussions

This study shows that age, carbohydrate intake and adherence to diet had significant relationships to HbA1c status of type-2 diabetic patients in Diabetes Clinic of Husada Hospital Jakarta. By age category, Karakelides,[11] stated that there is age-related decline in insulin sensitivity which is secondary to age-related changes in body composition (central obesity); and that a longer duration of DM is related to the increase in insulin resistance.[5] Longer duration of the disease will reduce insulin endogen, thus T2DM patients would need multiple medicines to control their blood glucose level.[12] Woo[13] stated that higher intake of protein, lipid, zinc, and vitamin E affected good glycaemic control significantly, and macronutrient composition intake in elder diabetic patient was better in good glycemic (60:20:20) compared to poor glycaemic control patients (71:15:15).

Most diabetic patients were reducing their carbohydrate-sourced foods in order to lower their total daily calorie intake. This study shows that although there was no statistically significant relationships between protein, fat, and fiber intake to HbA1c status, subjects who had high carbohydrate intake significantly had poor glycemic control. This is in accordance to the fact that medical nutrition therapy is necessary in preventing diabetes, managing existing diabetes, and preventing or delaying the rate of developing diabetes complications.[14] In addition to macronutrients intake, adherence to diet had statistically significant relationship to HbA1c status.

Study Limitation

This study had recall bias threat in duration of diabetes and disease complications, because the data recorded were from patients' self-report without further validation from physical examination and laboratory finding.

Conclusion

In conclusion, younger type-2 diabetic patients (age <55 year old) and patients with HbA1c level ≥7.0% are recommended to be well informed about their diet, especially with regards to type of macronutrient-rich foods.

Conflict of Interest

Authors declared no conflict of interest regarding this study.

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References

1. Suyono S. Diabetes melitus di Indonesia. Dalam: Sudoyo AW, Setiyohadi B, Alwi I, Simadibrata M, Setiati S, editor. Buku Ajar Ilmu Penyakit Dalam. Jakarta: Interna Publishing; 2009. [Google Scholar]
2. Hermansen MLF, Eriksen NMB, Mortensen LS, Holm L, Hermansen K. Can the glycemic index (GI) be used as a tool in the prevention and management of type 2 diabetes. Rev Diabetic Stud 2006;3:61. [Google Scholar]
3. Suyono S. Kecenderungan peningkatan jumlah penyandang diabetes. In: Soegondo S, Soewondo P, Subekti I. Penatalaksanaan Diabetes Melitus Terpadu. Jakarta: Fakultas Kedokteran Universitas Indonesia; 2009. [Google Scholar]

4. Waspadji S. Komplikasi kronik diabetes: Mekanisme terjadinya, diagnosis dan strategi pengelolaan. In: Sudoyo AW, Setiyohadi B, Alwi I, Simadibrata M, Setiati S, editor. Buku Ajar IlmuPenyakitDalam. Jakarta: Interna Publishing; 2009. [Google Scholar]
5. Khattab M, Khader YS, Al-Khawaldeh A, Ajlouni K. Factors associated with poor glycemic control among patients with type 2 diabetes. Journal of Diabetes and Its Complications 2010;24:84. [Google Scholar]
6. Perkumpulan Endokrinologi Indonesia. Konsensus pengendalian dan pencegahan diabetes melitustipe 2 di Indonesia. 2011
7. Yannakoulia M. Eating behaviour among type 2 diabetic patients: a poorly recognized aspect in a poorly controlled disease. Rev Diabetic Stud 2006;3:11. [Google Scholar]
8. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. New England journal of medicine 2001 Sep;345(11):790-7. [Google Scholar]
9. Rawal LB, Tabb RJ, Williams ED, Chan C, Yasin S, Oldenburg B. Prevention of type 2 diabetes and its complications in developing countries: a riview. Int J Behav Med 2012;19:121. [Google Scholar]
10. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Medicine & Science in Sports & Exercise 2000;32. [Google Scholar]
11. Karakelides H, Irving BA, Short KR, O'Brien P, Nair KS. Age, obesity, and sex effects on insulin sensitivity and skeletal muscle mitochondrial function. Diabetes 2010;59:89. [Google Scholar]
12. Donelly LA, Morris AD, Evans JM. Adherence to insulin and its association with glycaemic control in patient with type 2 diabetes. Quarterly Journal of Medicine 2007;100:345. [Google Scholar]
13. Woo MH, Park S, Woo JT, Choue R. A comparative study of diet in good and poor glycemic control groups in elderly patients with type 2 diabetes mellitus. Korean Diabetes J 2010;34:303. [Google Scholar]
14. Franz MJ. Medical nutrition therapy for diabetes mellitus and hypoglycemia of nondiabetic origin. In: Mahan LK, Escott-Stump S, Raymond JL, editor. Krause's Food and the Nutrition Care Process. 13th ed. Missouri: Elsevier Saunders, 2012:675—710.

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Breastfeeding Pattern and Its Association with Nutritional Status and Salivary Secretory Immunoglobulin A Level In 3–6 Months Old Infants

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Abstract

Introduction: Breastfeeding pattern is a form of mother's behavior in giving breast milk to her baby. Breast milk supports the growth and development of the baby. The most common immunoglobulin in breast milk is secretory immunoglobulin A (sIgA) whose levels can be evaluated, one of the ways, from saliva samples examination. The purpose of the research were to determine the breastfeeding pattern and its association with nutritional status and salivary secretory immunoglobulin A level in 3-to 6-month-old infants.

Methods: A research with cross sectional design was conducted in Kiara Social Pediatric-Growth and Developmental Clinic Cipto Mangunkusomo Hospital Jakarta. A total of 54 healthy infants subjects aged 3–6 months old were taken using consecutive sampling method. Descriptive analysis, Chi Square, and Mann-Whitney test were used. P-values <0.05 were considered significant.

Results: Our results showed that subjects with normal nutritional status were 85.2%. The median of subjects' salivary sIgA level was 56.2 (2.5–536.4) µg/ml. We did not find significant difference regarding to subjects' nutritional status between good breastfeeding pattern group and poor breastfeeding pattern group (p>0.145), nor difference regarding to salivary sIgA level between good breastfeeding pattern group and poor breastfeeding pattern group (p>0.34).

Conclusion: Despite the un-significant results, this study showed that normal nutritional status tended to be more prevalent in group with good breastfeeding pattern than in poor breastfeeding pattern. Re-encouragement, socialization, and education to the breastfeeding mothers are needed to improve the good breastfeeding pattern.

Keywords Breast milk, breastfeeding mother, breastfeeding pattern, nutritional status, salivary sIgA

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Introduction

Breast milk is a form of natural food given to the importance of infants' growth and development. Breastfeeding is a physiological process to provide optimal nutrition to the infants in an optimal way. According to WHO/UNICEF 2004, breastfeeding is the most appropriate way in providing an ideal food for the achievement of growth and development of a healthy baby, and has biological and psychological influences for the mother and the baby.[1] According to Indonesian Basic Research of Health (RISKESDAS) in 2010, breastfeeding patterns are grouped into three categories: exclusive breastfeeding, predominant breastfeeding, and partial breastfeeding.[2] The good breastfeeding pattern can be defined as exclusive breastfeeding accompanied by good breastfeeding method.

Based on The National Socioeconomic Survey (SUSENAS) in 2013, the coverage of exclusive breastfeeding in 0–6 months infants in all provinces of Indonesia was 45.55%.[3,4] This figure is still far from the coverage target of exclusive breastfeeding by the Indonesian ministry of health per 2014, which was 80%. In 2012, WHO made the Implementation Plan on Maternal, Infant and Young Child Nutrition programme, which contained six points of nutritional targets to be achieved globally by 2025. Points number 5 of the nutrition targets is to increase the success rate of exclusive breastfeeding in the first 6 months of life, at least up to 50%.[5]

One of the components in breast milk that supports the immune system is immunoglobulins. Compared to other immunoglobulins, secretory immunoglobulin A (sIgA) has the highest level in breast milk, particularly in the early phase of breastfeeding. The sIgA is often regarded as body's first line of defense mechanism, because sIgA has an important role in mucosal immunity. These roles including to provide protection to various mucous membranes by neutralizing toxins and viruses found in the mucosa, and preventing adhesion of pathogens at mucosal epithelial cells. Mother transfers sIgA to her baby through breastmilk. In infants and children, salivary sIgA levels are often associated with allergic symptoms as well as upper respiratory tract infections. Research on sIgA level from salivary samples are still rare. A study conducted by Jafarzadeh,[6] found that salivary sIgA level were significantly higher in breast-fed children compared to children who only received formula milk from birth. A study conducted by Ananta et al,[7] found that malnutrition rate in infants who received formula milk were significantly higher than those who were in exclusively breast-fed group. Other studies connecting breastfeeding to nutritional status in Indonesia are still rare to be found.

The association between breastfeeding patterns and infants' nutritional status which measured by anthropometric measurements, as well as the association between breastfeeding patterns and salivary sIgA levels as indicator of first-line body defense mechanism were investigated to fulfill the aim of this study

Methods:

Subjects and Study Design

This study was conducted using cross sectional design that aimed to investigate the association between breastfeeding patterns with nutritional status, and the relationship between breastfeeding patterns with secretory levels of salivary sIgA in 3–6 months infants. This range of age was chosen due to the highest IgA secretion in baby's saliva which occurred temporarily at 3–6 months of age.[8] Age correction was applied on premature babies. Subjects with gestational age <32 weeks, on going infection, never received breast milk from birth, using medications (anti-cholinergic, anti-histamine, or anti-seizure), had a history of impaired fetal growth as well as abnormalities which affect enteral intake, and had abnormality/disorder affecting salivary production, were excluded from this study. Data was collected on February 23 until March 16, 2017 at Kiara pediatric clinic in Cipto Mangunkusumo Hospital Jakarta. A total of 54 healthy 3–6 months old infant subjects, which were chosen using consecutive sampling method, joined the research until the end of the study.

Data Collection

Data were collected from interview to obtain the characteristics of subjects and subjects' mothers. Interview using questionnaire and direct observation during breastfeeding were conducted to obtain data on breastfeeding categories. The Salimetrics® sIgA Indirect Enzyme Immunoassay kit was used for the quantitative measurement of salivary sIgA. Nutritional status was based on WHO weight for length Z-score 2006. The measurements performed using Seca® digital weight scale, as well as Seca® infantometer to obtain the anthropometric data.

Statistical Analysis

Data were analyzed using *Statistical Package for Social Science* (SPSS) version 20.0. The normality of data distribution was analyzed using Kolmogorov-Smirnov test. The variables that had normal distribution were presented as mean ± standard deviation, while non-normal distribution were presented as median (minimum-maximum). Association between breastfeeding pattern and nutritional status was analyzed using Chi Square test, and the association between breastfeeding pattern and saliva secretory IgA level was analyzed using Mann-Whitney test. Significance set limit was $p<0.05$.

Results

Characteristics of total 54 healthy infant subjects (*i.e.* subjects' gender, birth weight, gestational age, delivery history, and hospitalization history), as well as the characteristics of subjects' mothers *(i.e.* mothers' age, education, occupation, and numbers of labour), are presented in Table 1.

Table 1 Characteristics of subjects and subjects' mother (n=54)

Characteristics	Value
Subjects' gender, n (%)	
Boy	33 (61.1)
Girl	21 (38.9)
Birth weight (g)	2707.83 ± 584.39*
Subjects' gestational age, n (%)	
Term	31 (57.4)
Preterm	23 (42.6)
Delivery history, n (%)	
Spontaneous	26 (48.1)
C-section	28 (51.9)
History of being hospitalized, n (%)	
Never	26 (48.1)
Yes	28 (51.9)
Hospitalized during neonatal period	20 (71.4)
Others	8 (28.6)
Mothers' age	
< 20 years old	1 (1.9)
20–30 years old	35 (64.8)
> 30 years old	18 (33.3)
Mothers' education, n (%)	
Low	12 (22.2)
Moderate	24 (44.5)
High	18 (33.3)
Mothers' occupation, n (%)	
Working	11 (20.4)
Not working	43 (79.6)
Numbers of labour	
Prime-paras	21 (38.9)
Multiparas	30 (55.6)
Grande-multiparas	3 (5.6)

*mean ± SD

Breastfeeding pattern is a formulation of model behavior in giving breast milk to the baby, including: whether breast milk is given exclusively/predominantly/partially, and how breastfeeding is performed (the breastfeeding method). The breastfeeding method was categorized based on 4 points: (1) breastfeeding position, (2) attachment between mother and baby, (3) breastfeeding frequency in a day, and (4) the breast engagement as well as the time that is needed in each cycle of breastfeeding.

Data on breastfeeding patterns were obtained by applying interview and observation to the subject's mother while breastfeeding. Interviews were conducted to determine: whether breast milk was given exclusively/partially/ predominantly, the frequency of breastfeeding, and how the breast engagement and the time needed in each cycle of breastfeeding. Meanwhile, observations were made to assess the position of breastfeeding and attachment between infants and mothers. Good breastfeeding pattern was

concluded if breastfeeding was performed exclusively with good breastfeeding method. Meanwhile, it is categorized into poor breastfeeding pattern if: (1) exclusive breastfeeding but poor breastfeeding method, (2) predominant breastfeeding accompanied by either good or poor breastfeeding method, or (3) partial breastfeeding accompanied by either good or poor breastfeeding method. The subjects' breastfeeding (BF) pattern characteristic is presented in Table 2.

Table 2 Subjects' Breastfeeding Pattern Characteristic (n=54)

Breastfeeding pattern	Value
Good (Exclusive BF with Good Breastfeeding Method), n (%)	19 (35.2)
Poor, n (%)	35 (64,8)
Exclusive BF with Poor Breastfeeding Method	0
Predominant BF with Good Breastfeeding Method	3 (8.6)
Predominant BF with Poor Breastfeeding Method	3 (8.6)
Partial BF with Good Breastfeeding Method	6 (17.1)
Partial BF with Poor Breastfeeding Method	23 (65.7)

Table 3 showed the nutritional status for subjects, which was made based on the weight-for-length Z-score interpretation on the WHO 2006 growth chart, with the determination of its category based on the Indonesian Pediatric Nutrition Care (Pediatric Nutrition Care) Recommendation Guideline 2011.[9]

Table 3 Subjects' nutritional status (n=54)

Nutritional Status	Value
Abnormal, n(%)	8 (14.9)
Obesity, n(%)	0
Overweight, n(%)	0
Undernourished, n(%)	5 (9.3)
Severely malnourished, n(%)	3 (5.6)
Normal, n(%)	46 (85.1)

The association between breastfeeding pattern and nutritional status of the subjects showed no significant difference in nutritional status between the good breastfeeding pattern group and poor breastfeeding pattern group (Table 4).

Table 4 Association between breastfeeding pattern and nutritional status (n=54)

Breastfeeding pattern	Abnormal nutritional status n (%)	Normal Nutritional Status n(%)	p Value*
Good (n = 19)	1 (5.3%)	18 (94.%)	0.145[CS]
Poor (n = 35)	7 (20%)	28 (80%)	

[CS]: Chi Square test; p*: statistically significant if p<0,05

The association between breastfeeding patterns and salivary sIgA levels was observed. Salivary sIgA levels have abnormal data distribution, for which non-parametric statistical tests Mann-Whitney was used. The non-parametric test results showed no significant difference in salivary sIgA level between good breastfeeding pattern group and poor breastfeeding pattern group (Table 5).

Table 5 Association between breastfeeding pattern and salivary secretory IgA level (n=54)

Breastfeeding pattern (n)	Salivary IgA levels (µg/ml)	p value
Good (19)	52.8 (2.5–536.4)	0.34 [MW]
Poor (35)	46.6 (2.5–449.8)	

[MW] : Mann-Whitney U; p*: statistically significant if p<0,05

Discussion

In this study, there was no significant difference in nutritional status between the subjects with good breastfeeding patterns and those with poor breastfeeding patterns (p=0.145). However, normal nutritional status tended to be more prevalent in subjects with a good maternal breastfeeding pattern, which is 94.7% compared to 80% from the poor breastfeeding pattern group. Underweight and severe malnutrition were also more likely to be found in infants with poor breastfeeding patterns. This was similar to the study by Ananta et al.[7] which described that nutritional status was significantly found less in non-exclusively breastfed infants (p=0.01). A retrospective study by Mandic et al,[12] found that breast-fed infants gained

less weight than those who were not breastfed, however those who were breast-fed remained within normal growth curves for weight and age.

Higher normal nutritional status in infants with good breastfeeding pattern was possible because good breastfeeding pattern ensured breast milk to be obtained by infants more effectively. Breast milk greatly supports infant growth because, in addition to nutrient content, breast milk contains hormones and growth factors. The growth factors, as we know, are bioactive proteins. In particular, the function of these components is to improve the ability of gastrointestinal adaptation after the baby was born by stimulating the growth of gastrointestinal cells, the maturation of the gastrointestinal system, the formation of non-pathogenic bacterial colonies, and the development of gastrointestinal lymphoid tissue.[13] Thus, the more effective breast milk obtained by infants the better they will grow, which are reflected in the normal nutritional status.

There was no significant difference in salivary sIgA levels between the subjects with good maternal breastfeeding patterns and the subjects with poor breastfeeding patterns ($p=0.234$). The difference between these results with previous studies was possible because in the previous study, sIgA levels were compared only between group of subjects who received breast milk and who did not get breast milk. Meanwhile in this study, the comparison between the good and poor breastfeeding pattern were determined with criteria composed by various aspects other than exclusive breastfeeding itself (*i.e.* breastfeeding position, attachment between mother and baby, breastfeeding frequency in a day, and the breast engagement as well as the time needed in each cycle of breastfeeding). The combination of more complex aspects in defining good and poor breastfeeding patterns may allowed the different result of salivary sIgA level. The finding of non-significant association between breastfeeding pattern and salivary sIgA levels might be affected by the absence of psychological effects on the study subjects. Rhein et al.[14] found that emotions (stress, anger, sadness) had an effect on salivary sIgA levels ($z=-2.02$, $p<0.05$). In a meta-analysis study conducted by Herbert et al.[15] and Van Rodd et al.[16] concluded that psychological stress could affect T lymphocytes and B lymphocytes, *i.e.* the suppression of the number and function of the immune cell. Stress hormones, cortisol, and catecholamines, could be responsible for impacting the lymphocyte cells. B lymphocyte cells in the process will be stimulated to produce immunoglobulins, especially sIgA.[17,18] The decrease in B lymphocyte cells will also reduce the amount of sIgA produced. In an adult study, further observation and interviews on aspects of emotion and psychological stress can be done more easily. Research on saliva sIgA levels in infants and children often overlooks these aspects because the psychological aspects in children and infants are more difficult to be explored than in adults.

Another factor which may contributed to the significant results between breastfeeding pattern and salivary sIgA levels was the under-assessment of "oral care treatment" history using breast milk for non-oral feeding infants treated in inpatient room for neonates in RSCM. Oral care treatment was done by using colostrum or mature breast milk that dripped into the oral mucosa (especially to the inside part of buccal mucosa) for infants who did not receive food intake per oral (including not being breastfed). Oral care treatment using colostrum or mature breast milk, is believed to be a potential factor that can improve the immune system in infants. The process of absorption of immune factors contained in the milk through the oral mucosa, can stimulate the development of the infants' immune system.[19] Lee et al,[20] in their study of premature babies, found that giving colostrum to the oropharyngeal mucosa could significantly increase concentrations of salivary sIgA, prevent secretion of pro-inflammatory cytokines, and decrease the incidence of sepsis. Neonatal inpatient unit has implemented oral care methods since mid 2016. The oral care method is recommended to be applied everyday when the patients have been dicharged, in order to maintain infants' oral immune system. The finding of non-significant breastfeeding pattern-salivary sIga levels relation in this study may be caused by the under-assessment of subjects' oral care treatment history, considering that the method of oral care application could increase the salivary sIga level, eventhough the infants in the neonatal inpatient unit could not be breastfed.

It can be concluded that there is no significant relationship between breastfeeding patterns and nutritional status, and there was also no significant relationship between breastfeeding patterns and salivary sIgA levels of 3 to 6 months old infants. Despite the un-significant results, this study showed that normal nutritional status tended to be more prevalent in group with good breastfeeding pattern than in poor breastfeeding pattern. Re-encouragement, socialization, and education to the breastfeeding mothers are needed to improve the good breastfeeding pattern. Other factors that may affect salivary sIgA levels (*i.e*. "oral care treatment" history using breast milk, physical activity, emotions, and psychological stress) and other factors that may affect breastfeeding patterns (*i.e*. history of mothers' antenatal care), are needed to be assessed for the next research.

Conflict of Interest

The authors of this paper declare there is no conflict of interest regarding this research.

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References

1. Organization WH. Indicators for assessing infants and young child feeding practices. Geneva: WHO; 2010. Available from: http://www.unicef.org/nutrition/files/IYCF_Indicators_part_III_country_profiles.pdf
2. Riset Kesehatan Dasar (RISKESDAS): Badan Penelitian dan Pengembangan Kesehatan Departemen Kesehatan RI. 2013
3. SUSENAS. *Indonesia–survei sosial ekonomi nasional triwulan 3* (Modul). 2014. Downloaded from: http://microdata.bps.go.id (accessed May 20th, 2016).
4. *Pusat Data dan Informasi kementerian Kesehatan RI* (InfoDATIN). *Situasi dan analisis ASI ekslusif*. 2014.
5. World Health Organization. Global nutrition targets 2025: breastfeeding policy brief 5. Geneva: WHO; 2010. Downloaded from: www.who.int/nutrition/topics/nutrition_globaltargets2025/en/ (accessed July 16th, 2017).
6. Jafarzadeh A, Hassanshahi GH. The Comparison of salivary IgA and IgE levels in children with breast- and formula-feeding during infancy period. Den Res J 2007;4:11–7.
7. Ananta Y, Gandaputra E, Waiman E, Pratiwi IGAN, Marzuki NS, et al. Exclusive breastfeeding rate and factors associated with infant feeding practices in Indonesia. Paediatr Indones 2016;56:24–31 .
8. Weemaes C, Klasen I, Göertz J, Beldhuis-Valkis M, Olafsson O. Development of immunoglobulin a in infancy and childhood. Scand J Immunol 2003;58:642–8.
9. Sjarif DR, Nasar SS, Devaera Y, Tanjung C. *Rekomendasi Ikatan Dokter Anak Indonesia: Asuhan Nutrisi Pediatrik (Pediatric Nutrition Care)*. Jakarta: Badan Penerbit IDAI-UKK Nutrisi dan Penyakit Metabolik, 2011
10. United Nations Children's Fund (UNICEF . Programming Guide: Infant and young children feeding. Geneva: WHO; 2012.
11. Davanzo R, Monasta L, Ronfani L, Brovedani P, Demarini S. Breastfeeding in neonatal intensive care unit study group. J Hum Lact 2013;29(3):374–80 .
12. Mandic Z, Piricki AP, Kenjeric D, Hanicar B, Tanasic I. Breast vs. bottle: differences in the growth of Croatian infants. Matern Child Nutr 2011;7:389–96.

13. Kent JC, Mitoulas LR, Cregan MD, Ramsay DT, Doherty DA, Hartmann PE. Volume and frequency of breastfeeding and fat content of breast milk throughout the day. Pediatrics 2006;117(3):387.
14. Rhein G, Atkinson M, McCraty R. The physiological and phsycological of compassion and anger. Journal of Advancement in Medicine 1995;8(2):87–105.
15. Herbert TB, Cohen S. Stress and immunity in human: a meta-analytic review. Psychosom Med 1993;55:364–79.
16. Rood, Y.U. Van , Bogaards M, Goulmy E, Houwelingen, H.C. van . The effects of stress and relaxation on the in vitro immune response in man: a meta-analytic study. J Behav Med 1993;16:163–81.
17. Brandtzaeg P. Mucosal immunity: integration between mother and the breast-fed infant. Vaccine 2003;21(24):3382–8.
18. Kleinman PE, Walker WA. The enteromammary immune system: an important new concept in breast milk host defense. Dig Dis Sci 1997;24:876–8.
19. Rodriguez NA, Meier P, Groer M, Zeller JM, Engstrom JL, et al. A pilot study to determine the safety and feasibility of oropharyngeal administration of own mother's colostrum to extremely low birth weight infants. Advance in Neonatal Care 2010;10(4):206–12.
20. Lee J, Kim HS, Jung YH, Choi KY, Shin SH, et al. Oropharyngeal colostrum adminitsration in extremely premature infants: an RCT. Pediatrics 2015;135(2):357–65.

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ORIGINAL PAPER

Early-menarche as Determinant Factor for Metabolic-risks: An Epidemiology Perspectives among Adolescent Girls Age 13-15 years old in Jakarta-Indonesia

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Abstract

Introduction: Early menarche predicts higher body mass index (BMI) and adiposity in adult life, and it has been associated with risk factors of cardiometabolic diseases such as elevated triglycerides and waist circumferences also higher risk of adult diabetes. This study aims to explore early-menarche as determinant factor for metabolic-risks among adolescent girls age 13–15 years old.

Methods: This cross-sectional study was undertaken in adolescent girls age 13–15 years old in all five municipalities in Jakarta-Indonesia, from January 2014 to May 2016. Data collected by using standardized measures for dietary intake, nutritional status indicators, physical activity level, blood pressure, blood glucose and lipid profile, and statistically analyzed by independent-t or Mann-Whitney test.

Result: A total of 194 adolescent girls participated in this study. Early menarche was found in 22.68% of all subjects. There was no association between menarche status and daily macronutrients intake pattern and physical activity level score. There was asscociation between menarche status and nutritional status indicators. Early menarche subjects had significantly body mass index (BMI) ($p<0.001$), CDC-percentile ($p<0.001$), WHO Z-score ($p<0.001$), and waist circumference (WC) values ($p=0.02$). Furthermore, early menarche subjects also had higher systolic blood pressure ($p=0.035$), total cholesterol level ($p=0.028$), LDL-cholesterol level ($p=0.013$), and triglyceride level ($p=0.026$). There was no association between menarche status and diastolic blood pressure, fasting blood glucose, HDL-C level, and lipid profile ratio.

Conclusion: Early menarche is an important determinant factor of metabolic risks, and balance between dietary intake and physical activity level should be prioritized among them.

Keywords Critical Care Nutrition; early menarche; adolescent girls; metabolic risks; dietary intake, nutritional status indicators

Introduction

Adolescence is an important period of life because puberty occurred in this phase which marked by changes in the biological, physiological, psychosocial, and cognitive aspects.[1,2] Physical and developmental changes in adolescent are strongly influenced by nutritional state. Adolescent require

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some of the highest energy and protein than any other age group due to the high velocity of growth.[3] Nutrition is important at any different stage of life and poor nutrition has a great impact across generations. Adolescent girls will also become a mother who would conceive and give birth. For example, an anemia woman is likely to deliver a low birth weight baby. Otherwise, the complications during pregnancy or delivery will increase when an obese woman is pregnant, such as premature delivery and a low birth weight baby, or if her pregnancy is considered full term, her baby has a great risk to grow into obese child and adolescent.[4]

Adolescent girls are characterized by the spurt in somatic growth, secondary sexual characteristics development, and the first menstrual period which called menarche.[5] The timing of menarche is affected by many factors such as endogenous hormonal regulations, nutritional status, genetic, environmental conditions, socioeconomic status, and education. Nutrition can influence the production of gonadotropin hormone. The formation of gonadotropin hormone and other hormones is accelerated by good nutrition thus affect the coming of menarche. Several studies reported there was an association between nutritional status with age at menarche. Underweight associated with menarche delay, while obesity associated with early sexual maturation.[6,7] Age at menarche get a great attention because of its influence on health implications. Early age at menarche has associated with higher body mass index (BMI) and excess body fat in adult life.[8] Mueller, et al[9] have reported that early age at menarche is associated with risk factors of cardiometabolic diseases as elevated triglycerides and waist circumferences also higher risk of adult diabetes. This study aims to explore early-menarche as determinant factor for metabolic-risks among adolescent girls aged 13–15 years old in Jakarta.

Materials and Methods

This cross-sectional study was undertaken in adolescent girls aged 13–15 years in all five municipalities in Jakarta-Indonesia, from January 2014 to Mei 2016. This study was part of previous study which was already published.[10] Subjects were recruited by multistage random sampling from Public and Private Junior High School within the municipalities. Selected schools, which have more than 60 female students were randomised by using online randomization (www.randomizer.org) to get five Public and five Private Junior High Schools. Sampling was done after obtaining permission from the Local National Unity and Politics of Jakarta. There were two selected schools refused to participate and withdrew from the study. Minimal sample size required for this study was 278 girls based on sample size calculation using prevalence of early menarche of 23.6%[6] for degree of significance alpha of 5% and degree of reliability of 5%. This study was approved by the Health Research Ethics Committee Faculty of Medicine Universitas Indonesia Cipto Mangunkusumo Hospital (No.634/H2.F1/ETIK/ 2013).

Medical history, general physical examination, and anthropometric measurement were performed in the subjects. Subjects were interviewed on their socio-demographic characteristics, age of menarche (early menarche status was defined as menarche before 12 years of age), dietary nutrients intake, and physical activity. Interview on dietary nutrients intake at during the past month, including food sources and quantity of energy, carbohydrate, protein, fat, and fiber intake, and also the way to prepare and cook the meals, were done by experienced nutritionist using the semi-quantitative Food Frequency Questionnaire (FFQ) then adjusted by the estimated size of the household which compared with food models. Results were analyzed using Nutrisurvey 2007. While physical activity level was assessed by using the Physical Activity Questionnaire (PAQ), i.e. PAQ-for children (PAQ-C) used to adolescent girls aged 13-14 years and PAQ-for adolescent (PAQ-A) used to adolescent girls aged 15 years.

Blood pressure measurement was performed to get systolic and diastolic blood pressure and nutritional status was evaluated using four indicators: weight (kg) per height $(m)^2$ (Body Mass Index; BMI), BMI according to WHO Z-score and CDC-percentile, and waist-circumference (WC). Waist-circumference was measured at the mid point between the last rib and the iliac crest.

A total of 7 ml of venous whole blood was drawn from the cubital vein by a trained phlebotomist at 7.00 until 10.00 in the morning after subject fasted for 12 hours for examination of fasting blood glucose. Blood sample was kept at room temperature for 30-45 minutes, and centrifuged at 1500 rpm for 15 minutes at 4°C to get blood serum and use for examination of total cholesterol level. Data of fasting blood glucose and total cholesterol level were recorded using special forms. The remaining blood serums were kept at -20°C at Dharmais Hospital National Cancer Center Laboratory for two years and were used for examining HDL cholesterol and triglyceride level using enzymatic colorimetric method. LDL cholesterol was calculated using the Friedewald equation (LDL cholesterol = total cholesterol – HDL cholesterol – (triglyceride/5).

Data were recorded using special forms. Data were edited, coded, and submitted into working sheets in the computer using Statistical Package for the Social Sciences (SPSS) version 20.0. Data were presented into descriptive and analytical approaches. Statistical analyses using unpaired t test or Mann-Whitney test were conducted to determine daily macronutrients intake pattern, nutritional status indicator, physical activity level (PAL), and metabolic profiles based on menarche status.

Table 1 Subjects' Socio-demographic characteristics (n=194)

Variables	n (%)
Age, years	
13	101 (52.1)
14	82 (42.3)
15	11 (5.7)
Father	
Education status	
Up to Junior High School	75 (38.7)
Senior High School and over	119 (61.3)
Job status	
Permanent job	69 (35.5)
Non-permanent job	125 (64.5)
Mother	
Education status	
Up to Junior High School	90 (46.4)
Senior High School and over	104 (53.6)
Job status	
Permanent job	19 (9.8)
Non-permanent job	20 (10.4)
Not working	155 (79.8)
Family income, per month	
Up to IDR 3,000,000	162 (83.5)
More than IDR 3,000,000	32 (16.5)

IDR, Indonesia currency in rupiahs (1US$≈13,000 IDR)

Results

Subjects who met the study criteria (had experienced menstruation, without history of chronic disease and therapy on steroids, without physically and mentally disability, and subjects' parents provided written informed consent) were 230 girls. However, only 194 adolescent girls had completed the measurements, representing the eight junior high schools across Jakarta. Most girls came from a low-income family and characteristics of all subjects were summarized in Table 1. Subjects were stratified into two different group based on the menarche status (Table 2). Early menarche was found in 22.68% of all subjects. All nutritional status indicators (BMI $p<0.001$, CDC-percentile $p<0.001$, WHO Z-score $p<0.001$, WC $p=0.02$) were associated with menarche status. High BMI, CDC-percentile, WHO Z-score, and WC were found in subjects with early menarche. There was no association between menarche status and daily macronutrients intake pattern and physical activity level score.

Regarding to the metabolic risks, in this study, menarche status was associated with systolic blood pressure ($p=0.035$), total cholesterol level ($p=0.028$), LDL-cholesterol level ($p=0.013$), triglyceride level ($p=0.026$). However, there was no association between menarche status and diastolic blood pressure, fasting blood glucose, HDL-C level, lipid profile ratio.

Table 2 Subjects' metabolic profiles based on early menarche status

Variables	All (n=194)	Early Menarche (n=44)	Non-Early Menarche (n=150)	*p*-value
Daily macronutrients intake pattern				
Energy, kcal	1584 (703–2963)†	1689±519‡	1579 (703–2963)†	0.415¶
Carbohydrate, g	213.1 (74.3–432.9)†	228.8±74.4‡	213.3 (74.3–432.9)†	0.833¶
Fats, g	55.8 (14–121)†	58 (14–121)†	57.6±19.7‡	0.342¶
Protein, g	46.4 (13.8–229.0†	48.8 (21.1–110.1)†	46.2 (13.8–229.0)†	0.863¶
Fiber, g	5.7 (0.8–20.4)†	5.1 (1.5–20.4)†	6.0 (0.8–19.6)†	0.598¶
Nutritional status indicator				
BMI, kg/m^2	20.0 (13.0–32.6)†	22.2±3.8‡	19.3 (13.0–32.2)†	**<0.001**¶
CDC-percentile	59.2 (0 – 98.6)†	74.9 (1.6–98.6)†	51.1 (0–98.0)†	**<0.001**¶
WHO z-score	0.1±1.1‡	0.7±1.0‡	0±1.1‡	**<0.001**§
Waist-circumference, cm	64.5 (50.5–88.0)†	67.0 (55.0–88.0)†	63.0 (50.5 – 88.0) †	**0.02**¶
Physical activity level score	1.9±0.3‡	1.9±0.4‡	1.8±0.3‡	0.215§
Blood pressure, mmHg				
Systolic	110 (80–140)†	110 (84–122)†	110 (80 - 140)†	**0.035**¶
Diastolic	70 (58–90)†	70 (60–84)†	70 (58–90)†	0.805¶
Fasting blood glucose, mg/dL	83 (55–163)†	82.5 (57.0–163.0)†	82.3±11.6‡	0.912¶
Lipid profiles, mg/dL				
Total-C	170.7±25.7‡	178.2±24.2‡	168.5±25.8‡	**0.028**§
LDL-C	102.7±25.6‡	111.1±23.6‡	100.2±25.8‡	**0.013**§
HDL-C	49.3±10.0‡	50.0±8.9‡	49.1±10.3‡	0.632§
Triglycerides	85 (34–248)†	72 (39–240)†	88 (34–248)†	**0.026**¶
Lipid profile ratio				
Total-C:HDL	3.39 (1.74-11.29)†	3.58 (2.34-7.10)†	3.36 (1.74-11.29)†	0.248¶
Triglyceride:HDL	1.73 (0.54-8.00)†	1.52 (0.66-5.22)†	1.89 (0.54-8.00)†	0.070¶
LDL:HDL	2.03 (0.61-8.92)†	2.22 (1.21-5.44)†	1.99 (0.61-8.92)†	0.075¶

All: all subjects; early menarche: subjects with early menarche status which defined as menarche before 12 years of age ; non-early menarche: subjects with non-early menarche status which defined as menarche 12 or over 12 years of age; C: cholesterol.
†median (minimum–maximum), ‡mean±SD; §unpaired *t* test; ¶Mann–Whitney U test.

Discussion

To our knowledge, this study was the first research conducted in Indonesian adolescents girls that assess metabolic risks in early menarche accompanied by other factors such as daily macronutrients intake pattern, nutritional status indicators, and physical activity level. The advantages of this research include that it could be generalized to the population of adolescent girls aged 13–15 especially in low-income urban area representing the eight junior high schools among all municipalities in Jakarta, and the random selection. Blood sample collection was also carried out at the same time, i.e. in the morning after subjects fasted to prevent influence of dietary intake to metabolic profile. Subjects were also carried out on fairly strict inclusion criteria to minimize other variations of health conditions that could affect the subjects. Meanwhile, the weakness of this study as it used cross-sectional design that could be threatening by the possibility of the recall bias when taking dietary intake and physical activity data.

In our study, early menarche was found in 22.68% of all subjects. Similar result was reported in other study. A study in 161 students of junior high school in Semarang reported 23.6% subjects experienced early menarche.[11] The age at menarche has decreased steadily worldwide in recent decades. Study in South Korea found the declining trend in the average age at menarche 0.68 years per decade.[12] Cross-sectional and longitudinal data general population of the United States reported that there was a declining average age at menarche approximately 14.8 years in the late 1800's to 13 years by 1950. The average age at menarche has declined over time probably as a result of improvements in nutrition and overall health.[13]

It has been shown that childhood overweight are related to earlier menarche and that earlier menarche is associated with higher body mass index (BMI) in later life.[8] In this study, subjects with early menarche had higher nutritional status indicators such as BMI, BMI CDC-percentile, BMI WHO Z-score, and waist circumference (WC) than non-early menarche subjects. Our results are consistent with other studies showing associations of early menarche status with nutritional status indicators. A cohort study over a 25 years of follow-up in 2,583 women (African-American=1,333; White=1,250) aged 18–30 years at baseline from the Coronary Artery Risk Development in Young Adults (CARDIA) study showed that earlier menarche was associated with grater BMI and WC for both African-American and White women.[14] Mueller et al.[9] reported there was association between early menarche and higher WC and BMI in 8,075 women aged 35–74 years in the Brazilian Longitudinal Study of Adult Health. Earlier menarche (<11 years vs. 13–14 years) was significantly associated with higher WC and BMI. Study in 12,336 women who participated in the Korean National Health and Nutrition Examination Survey 2010 to 2013 reported that women with early menarche were more likely to exhibit a higher BMI and WC relative to the other groups.[15] The association between onset of menarche and waist circumference may be attributable to the physiological changes of hormones and body composition as the effect of gain of fat mass, the hormonal status and normal physiological changes in body composition during puberty in adolescent girls.[16]

Nutritional status becomes an important factor in menarche. Adolescent girls with undernutrition would experience delay in menarche compared to adolescent girls with normal nutritional status. Delay in menarche is due to a low intake of calories, carbohydrate, fat, protein, and other nutrients, which then affect production of hormone.[6] Several study showed that early menarche mostly was associated with low fiber intake[17-19] and high animal protein.[18-21] In this study, there was no differences in daily macronutrients intake pattern between two groups. A prospective study in 213 girls follow-up to 4 years showed that there was no association between energy intake (carbohydrate, fat, and protein) and early menarche.[22] It might be explained to the fact that nutrient intake does not directly affect menarche status. Macronutrients intake in our study was obtained from interviewed that based on subject's memory on that time and may describe short term intake. Menarche status is more related to excess body fat in which describes a longterm condition of imbalance energy as a result of high energy intake and could be assessed by

anthropometric measurements using nutritional status indicators. Most of subjects had low energy intake based on Indonesian Recommended Dietary Allowances (RDA). Energy intake lower than energy adequacy could be caused by many factors. RDA is used for planning basic food consumption of people in particular region to achieve optimal nutrition and health status. RDA is not intended to assess level of individual nutrient intake. Individual energy adequacy should be based on age, sex, weight, height, physycal activity level, thermic effect of food, and growth factors specifically for children and adolescents.[23] In this study, the largest macronutrient contribution to total energy intake was derived from fat. This could be caused by various factors such as economic factors, food availability, and diet pattern. Family income under regional minimum wage could affect the fulfillment of quality and quantity nutritional intake. They chose type of food with high dense-energy especially high fat diet which more affordable than balance diet. Most of the parents have low education level which could influence diet pattern in the family.[10]

Several study showed that physical activity level associated with menarche status. Dreyfus et al. [14] reported that early menarche was associated with lower physical activity level for both African-American and White women. In this study, there was no difference in physical activity level score between two groups in our study. It might due to the fact that most of girls has low physical activity level. Physical activity tends to decrease with age, especially after a child becomes adolescent, which often occurs in adolescent girls. In childhood, physical activity and exercise is a positive activity and fun activity, but as age increases, that perception has changed. Research shows that the decrease in physical activity tends to occur at the age of 13 to 18 years.[24]

The timing of menarche has been reported to affect metabolic and cardiovascular health in adolescence.[25] Several studies reported association between early menarche and increased risk for cardiovascular disease such as type 2 diabetes, metabolic syndrome, and high blood pressure.[14] Early age at menarche has been associated with increased blood pressure in many studies. In this study, menarche status was associated with systolic blood pressure, but not with diastolic blood pressure. Women with earlier menarche were more likely to have reported hypertension at recruitment than those with later menarche, according to a UK population-based cohort study, The Million Women Study. This study recruited 1.3 million women 50 to 64 years of age who had been invited for routine breast cancer screening by the National Health Service (NHS) screening programs of England and Scotland between 1996 and 2001. They reported an increased risk of hospitalization or death from hypertensive disease in women with early menarche.[25] Similar result of our study was found in a population-representative birth cohort, "Children of 1997", in Hong Kong which assessed the association of maternal age of menarche with blood pressure. Earlier maternal age of menarche was associated with higher systolic blood pressure in adolescence. Maternal age of menarche was not associated with diastolic blood pressure. The association of maternal age of menarche with systolic blood pressure possibly partially driven by the association of earlier maternal age of menarche with greater excess of body fat and/or with earlier pubertal timing.[26]

Early menarche is strongly associated with obesity, which increases the risk of cardiometabolic disease. It might be because obesity and puberty may influence each other through a hormonal changes and insulin resistance.[14] In this study, menarche status did not related to fasting blood glucose level. In contrast, a cross-sectional study of 2,039 premenopausal and postmenopausal women aged 44 to 56 years in Korea demonstrate a significant association between earlier age at menarche and increased risk of dysglycemia even at the pre-diabetes level.[27] There was no association between fasting blood glucose and age at menarche in this study. This shows that insulin resistance not always characterized by elevated glucose level.
Overweight or obesity in adolescent, particularly accumulation of fat in abdominal would increase waist circumference which related to increases risk of dyslipidemia, hypertension, insulin resistant or hyperinsulinemia, and impaired glucose tolerance or type 2 diabetes, which led to metabolic syndrome.[28] The metabolic syndrome is likely to increase in developing countries due to changes in diet and lifestyle. The increased consumption of

high-calorie diet and fast food containing high amount of carbohydrate and fat, along with the increasing sedentary lifestyle shows the major factors that can increase prevalence of overweight in adolescent.[29] It was found that adolescent girls with early menarche have higher BMI and waist circumference than adolescent with normal onset of menarche in our study. Early menarche related to amount of adipose tissue, which could be assessed by antropometric measurement such as waist circumference and BMI. Excess of fat is influenced by imbalance of energy intake and physical activity level. As we know, excess of fat was reported as one of risk factor that led to metabolic disease due to its association with metabolic risk factors. Therefore, it can be concluded that early menarche is an important determinant factor of metabolic risks. Adolescents with early menarche already have several metabolic risks that will become to any metabolik disease in later life. Nutrition is a crucial matter in adolescent period. It is important to provide adolescent an adequate intake of nutritious food which met their nutritional needs and encourage them to be more active.

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Conflict of Interest

The authors of this paper declare there is no conflict of interest regarding this research.

References

1. Batubara JRL. Adolescent development (*Perkembangan remaja*. *Sari Pediatri* 2010;12:21-9.
2. Karapanou O, Papadimitriou A. Determinant of Menarch. Reproductive Biology and Endocrinology 2010;8:115.
3. Children, t. (Save) . Adolescent Nutrition Policy and Programming in SUN+ Countries. London: NXP Europe Ltd; 2015.
4. Branca F, Piwoz E, Schultink W, Sullivan LM. Nutrition and health in women, children, and adolescent girls. BMJ 2015;351:27.
5. Mounir GM, El-Sayed NA, Mahdy NH, Khamis SE. Nutritional Factors Affecting the Menarcheal State of Adolescent School Girls in Alexandria. J Egypt Public Health Assoc 2007;82(3&4):239.
6. Juliyatmi RH, Handayani L. Nutritional Status and Age at Menarche on Female Students of Junior High School. International Journal of Evaluation and Research in Education 2015;4(2):71.
7. Stang J. Adolescent nutrition. In: Brown JE, editor. Nutrition through life cycle 4th ed. Belmont: Wadsworth; 2011.
8. Schnabel RB. Is It All Determined at Menarche. Circulation 2015;131:227-9.
9. Mueller NT, Duncan BB, Barreto SM, Chor D, Bessel M Aquino EML, , Pereira MA, et al. Earlier age at menarche is associated with higher diabetes risk and cardiometabolic disease risk factors in Brazilian adults: Brazilian Longitudinal Study of Adult Health (ELSA-Brasil. Cardiovascular Diabetology 2014;13(22):1.
10. Hariani R, Bardosono S, Djuwita R, Sutandyo N, Kumala M, Sungkar A, et al. Diet and estradiol level in adolescent girls. Paediatrica Indonesiana. 2016:56(3):134-8.
11. Susanti AV S. Faktor risiko kejadian menarche dini pada remaja di SMPN 30 Semarang. J Nutr College 2012;1:386-407.

12. Cho GJ, Park HT, Shin JH, Hur JY, Kim YT, Kim SH, et al. Age at menarche in Korean population: Secular trends and influencing factors. Eur J Pediatr 2010;169:89-94.
13. Dreyfus J. Early Pubertal Development and Cardiometabolic Risk: a Life Course Approach. (dissertation). Minnesota: The University of Minnesota, 2013.
14. Dreyfus J, Jacobs DR, Mueller N, Schreiner PJ, Moran A, Carnethon MR, et al. Age at menarche and cardiometabolic risk in adulthood: the Coronary Artery Risk Development in Young Adults Study. J Pediatr 2015;167(2):344.
15. Won JC, Hong JW, Noh JH, Kim DJ. Association Between Age at Menarche and Risk Factors for Cardiovascular Diseases in Korean Women. The 2010 to 2013 Korea National Health and Nutrition Examination Survey. Medicine 2016;95(18):1-7.
16. Chan NPT, Choi KC, Nelson EAS, Chan JC, Kong APS. Associations of pubertal stage and body mass index with cardiometabolic risk in Hong Kong Chinese children: A cross-sectional study. BMC Pediatrics 2015;15:136.
17. Ridder, C.M. De , Thisjssen JHH, Veer PV, Duuren RV, Brunning PF, Zonderland ML, et al. Dietary habits, sexual maturation, and plasma hormones in pubertal girls: a longitudinal study. Am J Clin Nutr 1991;54:805-13.
18. Moisan J, Meyer F, Gingras S. Diet and age at menarche. Cancer Causes Control 1991;1:149-154.
19. Schimdt TJ, Litwack G. Biochemistry of Hormones. In: Textbook of Biochemistry with Clinical Correlation. 6th ed. Canada:Wiley-Liss Publication. 2006. p.892-942.
20. Wen X, Li D, Tozer AJ, Docherty SM, Iles RK. Estradiol, progesterone, testosterone profiles in human follicular fluid cultured granulose cells from luteinized pre-ovulatory follicles. Reprod Biol Endocrinol 2010;8:117-26.
21. Simpson ER. Sources of estrogen and their importance. J Steroid Biochem Mol Biol 2003;86:225-30.
22. Maclure M, Travis LB, Willet W, MacMahon B. A prospective cohort study of nutrient intake and age at menarche. Am J Clin Nutr 1991;54:649-56.
23. Hardinsyah, Riyadi H, Napitupulu V. Kecukupan Energi, Protein, Lemak dan Karbohidrat. Departemen Gizi Masyarakat FEMA IPB dan Departemen Gizi FKUI. 2012.
24. Aznar-Lain S, Webster T, Chicharro JL. Physical Activity and Health in Children and Adolescents. 2006. http://www.msssi.gob.es/en/ciudadanos/proteccionSalud/adultos/actiFisica/docs/actividadFisicaSaludIngles.pdf. (accessed July 18th 2016).
25. Canoy D, Beral V, Balkwill A, Wright FL. Kroll ME, Reeves GK, Green J, Cairns BJ. Age at Menarche and Risks of Coronary Heart and Other Vascular Diseases in a Large UK Cohort. Circulation 2014;131:237-44.
26. Lai TC, Leung GM, Schooling CM. Maternal Age of Menarche and Blood Pressure in Adolescence: Evidence from Hong Kong's "Children of 1997" Birth Cohort. PLoS ONE 11(7):1-10.
27. Baek TH, Lim NK, Kim MJ, Lee J, Ryu S, Chang Y, et al. Age at menarche and its association with dysglycemia in Korean middle-aged women. Menopause 2015;22(5):542-8.
28. Rodriguez G, Moreno LA, Blay MG, Blay VA, Garagorri JM, Sarria A, et al. Body composition in adolescents: measurements and metabolic aspects. Intenational Journal of Obesity 2004;28.
29. Ventura AK, Loken E, Birch LL. Risk Profiles for Metabolic Syndrome in a Nonclinical Sample of adolescent Girls. Pediatrics 2006;118(6):24

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ORIGINAL PAPER

Commercial Powder and Ready-to-use Enteral Nutriton had better Accuracy in Energy and Macronutrients Content Compared to Homebrew.

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Abstract

Introduction: In Indonesia, homebrew, commercial powder and ready-to-use enteral formula have been used in hospital and at home. However, the decision to choose enteral formula is influenced by various things and often does not based on evidence-based practice. This study aims to compare macronutrient accuracy and microbial contamination status of homebrew, commercial powder and ready-to-use enteral formula. Furthermore, this result was expected to become a reference in deciding the enteral formula to use.

Methods: The design was a cross sectional comparative study. We collected 63 enteral nutrition samples from 7 different ICUs, wards and homes, in Jakarta from April to June 2012. Macronutrient accuracy was assessed by comparing energy, carbohydrate, protein and fat to their nutritional fact labels. The macronutrient accuracy was considered to be good if the deviation was <10% and bad if >10%. Microbial contamination was considered to be acceptable if the contamination in enteral formula by coliform was <3 MPN/mL, total plate count (TPC) <10 CFU/mL, and *Staphylococcus aureus* < 10 CFU/mL.

Results: Homebrew had bad accuracy in calorie, carbohydrate and fat; commercial powder enteral formula had slightly bad accuracy in fat; ready-to-use enteral formula had bad accuracy in carbohydrate and fat. There was no sample contaminated by *Staphylococcus aureus*. Contamination by coliform and TPC was most acceptable in ready-to-use enteral formula than others, and the least in homebrew.

Conclusion: Commercial and ready-to-use enteral nutrition are more acceptable than homebrew in macronutrients accuracy and microbial contamination status.

Keywords enteral formula, macronutrients accuracy, microbial contamination

Introduction

Hospital malnutrition in Indonesia is becoming a serious problem, however, there is no data regarding this issue. In industrialized countries, several studies have identified this condition in 25–50% of the hospitalized population.[1] Malnourished patients will certainly have higher rate of morbidity and mortality as well as longer hospital stay and higher cost.[2]

There are several factors related to the etiology of hospital malnutrition, among others are the underlying illness for which the patient is hospitalized, and quality of hospital medical care which includes nutrition support care.[1]

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Insufficiency in energy and macronutrient composition is a critical problem which, among others, is related to diet portioning and distribution, to fulfill the nutritional needs of the patients.[2] Although there are few studies comparing the energy and macronutrient content of diet formulation however, different from micronutrients, it is assumed that food preparation does not lead to significant changes in macronutrients amount.[2]

Aside from the quality of nutrient content, the safety of enteral formula given to the hospital patients is also very important and can pose a significant risk to the patients. In general, the contamination of the formula with microorganism can occur at any point starting from the production, to preparation, storage, or administration process.[3] During the preparation in the hospital or healthcare setting, the process of mixing, reconstitution, or dilution of modular products and formula with water, and/or pouring the formula into an administration container are critical points for contamination. The contaminated feeding increases the risk for nosocomial infections such as diarrhea, pneumonia and septicaemia. A study in the Philippines found that 75–96% of blenderized tube feeding samples were contaminated, while in Saudi Arabia the percentage was reported higher.[4]

Sterile ready-to-use (RTU) and commercial powders are available in Indonesia, however homebrew is still used. This preliminary study aims to compare the use of different enteral nutrition formula i.e. ready to use enteral formula, commercial powder and homebrew, in terms of energy and macronutrient composition accuracy, as well as the contamination.

Methods

Sample inclusion criteria including: 1) Homebrew, commercial powder and ready to use enteral nutrition sample which were taken from ICU, wards and homes in Jakarta; 2) Sample was kept in the standard collection cups, and 3) Sample was brought to the laboratory by using the cold box. The samples were excluded if the transportation of the samples to the laboratory were more than four hours.

Data collected were analyzed to get accuracy of the energy and macronutrition content of each product, and the microbial contamination status based on the coliform, total plate count (TPC) and *Staphylococcus aureus* counts. The energy and macronutrient content value was considered to be good, if it has less than 10% deviation of energy, carbohydrate, protein and fat between the laboratory findings compared to its nutritional fact label. On the other hand, the nutritional content value was considered to be poor, if it has 10% and more deviation of energy, carbohydrate, protein and fat in the laboratory findings compared to its nutritional fact label. For microbial contamination status, it was considered acceptable if the coliform counts was less than 3 MPN/mL, the TPC was less than 10 CFU/mL, and the *Staphylococcus aureus* was less than 10 CFU/mL.[5]

Data were then managed by using the Statistical Program for Social Sciences (SPSS) version 11.5. To compare the energy and macronutrient content accuracy of each of the product, paired-t and/or Wilcoxon test was used. McNemar-test was used to compare the energy and macronutrient accuracy status and the microbial contamination status between the products. The p-value of less than 0.05 was used as the significance level.

Results

This study collected 21 samples from each of three different preparation locations, i.e. ICU and wards of the selected seven hospitals and home care patients in Jakarta per-product tested. The energy and macronutrient content level accuracy of different enteral preparation, as shown in Table 1, revealed that in average the homebrew product has poor accuracy (having more than 10% deviation) except for protein content. On the other hand, the commercial powder formula, in average, only has poor accuracy for the fat content, and ready-to-use formula has poor accuracy for carbohydrate and fat contents. Furthermore, Table 2 shows the proportion of energy and macronutrient accuracy between the three different enteral formulas.

Table 1 Macronutrient level accuracy of different enteral preparation formula

Macronutrients	Homebrew (1)			Commercial (2)			Ready-to-use (3)			p-value
	Fact label	Laboratory	Deviation	Fact label	Laboratory	Deviation	Fact label	Laboratory	Deviation	
Calorie	Kcal*	Kcal*	%*	Kcal^	Kcal^	%^	Kcal*	Kcal*	%*	
	100 (87-155.3)	60.2 (41.3-154.1)	-46.2 (-59.6-53.1)	103 (10.1)	95.6 (10.3)	-7.4 (11)	150 (118.5-150)	135.8 (96.5-148.5)	-2.6 (-10.7-10.2)	1) 0.003a 2) 0.006b 3) 0.001a
Carbohydrate	g^	g*	%*	g^	g^	%^	g*	g*	%*	
	15.2 (2.8)	6.9 (3.6-21.2)	-26.1 (-43.6-33.6)	14.5 (3.4)	15.5 (3.4)	3.8 (9.7)	17.3 (13.8-18.8)	21.1 (14.3-24.3)	14.9 (2.1-27.9)	1) 0.001a 2) 0.092b 3) <0.001a
Protein	g*	g^	%*	g^	g^	%*	g*	g*	%*	
	3.6 (2.3-6.7)	2.9 (0.9)	-2.6 (-10-72.2)	3.7 (0.8)	3.5 (0.8)	-1.1 (-4.4-7.8)	3.1 (3.1-3.8)	3.0 (2.9-3.5)	-0.6 (-1.6- -0.2)	1) 0.016a 2) 0.112b 3) <0.001a
Fats	g^	g^	%^	g^	g^	%^	g*	g*	%*	
	3.0 (1.1)	1.6 (0.9)	-12 (10.2)	3.3 (1.3)	2.2 (1.2)	-10.2 (7.1)	6.3 (3.4-6.8)	4.4 (2.8-4.5)	-16.8 (-52- -5.2)	1) <0.001b 2) <0.001b 3) <0.001a

*, median (minimum-maximum); ^, mean (sd); a), Wilcoxon; b, paired-t

Table 2 Proportion of macronutrients accuracy of different enteral preparation formula for calorie-content accuracy

For Calorie-content accuracy

Type of formula:		Ready-to-Use		
		Good	Bad	p-value (McNemar)
Homebrew	Good	0	0	na
	Bad	21	0	
Commercial	Good	13	0	na
	Bad	8	0	

For Carbohydrate-content Accuracy:

Homebrew	Good	0	0	na
	Bad	1	20	
				0.031
Commercial	Good	1	6	
	Bad	0	14	

Table 2 (continued)

For Protein-content Accuracy:

Type of formula:		Ready-to-Use		
		Good	Bad	p-value (McNemar)
Homebrew	**Good**	**3**	**0**	**<0.001**
	Bad	17	1	
Commercial	Good	9	1	0.006
	Bad	11	0	

For Fats-content Accuracy:

Homebrew	Good	0	0	na
	Bad	0	21	
Commercial	Good	0	2	na
	Bad	0	19	

By using ready-to-use (RTU) formula as "gold standard", the proportion of poor energy accuracy is found in all of the homebrew samples, as compared to only 4 to 21 in RTU samples. On the other hand, there is no significant difference in the proportion of poor energy accuracy between RTU and commercial powder formula (p=0.344). Furthermore, almost all RTU and all homebrew samples had poor carbohydrate accuracy, and there is a significant lower proportion of poor carbohydrate accuracy in the commercial powder compared to the RTU formula (p=0.031). This evidence is similar with the proportion of poor protein accuracy, no significant difference between homebrew and RTU formula, but there is a significant lower proportion of poor protein accuracy in the commercial powder compared to the RTU formula (p=0.039). Finally, there is no significant difference in the proportion of poor fat accuracy in all samples.

Further analysis on the micro-organisms contamination, as shown in Table 3, revealed that there is no single sample contaminated by *Stahpylococcus aureus*, however, there are significant lower proportion of coliform and TPC contamination in the RTU compared to both homebrew and commercial powder formula (P<0.05).

Table 3 Proportion of microbial contamination of different enteral preparation

Coliform	Ready-to-Use		p-value (McNemar)
	Not contaminated	Contaminated	
Homebrew			
Not contaminated	6	0	**<0.001**
Contaminated	13	2	
Commercial			
Not contaminated	10	1	**0.021**
Contaminated	9	1	

TPC	Ready-to-Use		p-value
	Not contaminated	Contaminated	
Homebrew			
Not contaminated	2	0	**<0.001**
Contaminated	17	2	
Commercial			
Not contaminated	2	0	**<0.001**
Contaminated	17	2	

Discussion

Energy and macronutrient level accuracy of all preparations showed high degree in variation. In terms of macronutrient, homebrew formula has the highest deviation among all macronutrients. Compared to the study done by Mokhalalati,[6] this study showed that homebrew had the highest degree of variability in nutrient content and physical properties compared to commercial enteral formula. The average of variability ranged from 16–50%, while the commercial enteral formula was 4–7%.

The microbial contamination analysis showed that there was no formula contaminated by *Staphylococcus aureus*. However, this was not the case for TPC and coliform contamination. Among all the formula, ready-to-use had the least proportion of microbial contamination. Contamination through equipments and utensils of homebrew enteral formula were already reported by several publications.[4,6,7] This shows that the closed-system in preparation will limit microbial contamination.

Furthermore, the deviation of macronutrient value accuracy and microbial status found in this study has clinical and nutritional implication for malnourished patients and patients at risk of malnutrition. Although we used limited numbers of sample size in this study, it could be concluded that homebrew is inferior compared to commercial and RTU products, especially in energy and macronutrients accuracy, and microbial contamination status. Thus, it is recommended to use the ready-to-use or commercial formula for tube feeding in order to get accurate nutritional foods with low contaminant.

Conflict of Interest

Authors declared no conflict of interest regarding this study.

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References

1. Burgos R, Sarto B, Elío I, Planas M, Forga M, Cantón A, et al. Prevalence of malnutrition and its etiological factors in hospitals. Nutr Hosp 2012;27(2):469. [Google Scholar]
2. Viganó P, Silva N, Cremonezi C, Vannucchi G, and Campanelli M . Variation in the energy and macronutrient contents of the texture modified hospital diets. Rev Chil Nutr 2011;38(4):451. [Google Scholar]
3. Bankhead R, Boullata J, Brantley S, Corkins M, Guenter P, Krenitsky J, et al. Enteral nutrition practice recommendations. JPEN 2009;33(2):122. [Google Scholar]
4. Jalali M, Sabzghabaee AM, Badri SS, Soltani HA, Maracy MR. Bacterial contamination of hospital-prepared enteral tube feeding formulas in Isfahan, Iran. JRMS 2009;14(3):149. [Google Scholar]
5. BPOM RI. *Peraturan Kepala Badan Pengawas Obat dan Makanan RI No HK.00.06.1.52.4011 tentang Penetapan Batas Maksimum Cemaran Mikroba dan Kimia dalam Makanan*.
6. Carvalho MLR, Morais TB, Amaral DF, Sigulem DM. Hazard analysis and critical control point system approach in the evaluation of environmental and procedural sources of contamination of enteral feedings in three hospitals. JPEN 2000;24:296. [Google Scholar]
7. Sullivan MM, Sorreda-Esguerra P, Platon MB, Castro CG, Chou NR, Shott S, et al. Nutritional analysis of blenderized enteral diets in the Philippines. Asia Pac J Clin Nutr 2004;13(4):385. [Google Scholar]


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