

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; 10(2): 371-377
www.biochemjournal.com
 Received: 08-11-2025
 Accepted: 25-12-2025

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Glycaemic quotient (GQ): Development and proposal of a more precise tool for diet planning and preparation

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i2e.7606>

Abstract

Background: Diabetes is caused due to deficiency of insulin enzyme, either due to beta cell destruction, dysfunction, genetic mutation or it can be caused due to insulin resistance by the receptors on the cells. Insulin resistance and beta cell dysfunction can be measured using tools like HOMA scorings or METS scoring. But often they don't give correct results. Also, in developing countries and rural and community settings, calculating these scoring is not feasible. So, we need a tool to screen and predict metabolic risks and plan diet to prevent their onset.

Objectives

1. To Develop a more precise tool (Glycaemic Quotient (GQ)), based on Total Daily Energy Expenditure and Fasting Blood Sugar expressing capacity of the body to utilize glucose.
2. To derive stratified grading for Glycaemic Quotient (GQ) in males and females for clinical and personalised use.

Methods: The study population is 451 people attended general OPD at General Hospital, Ahwa, located in Dang district of Gujarat. The individuals were evaluated for vitals, FBS, BMI, BMR, TDEE, MCPD, physical activity, addictive habits and other co-morbidities. Correlation analysis was done using Pearson's coefficient and *p*-value less than 0.05 was considered statistically significant. A stratified grading system is devised for GQ for risk classification and clinical use.

Results: Mean GQ values were comparable between males (51 $\pm$ 15) and females (50 $\pm$ 15), yielding a stable normal range. GQ showed a weak positive correlation with BMI ($r = 0.222$, $p < 0.001$) and a strong positive correlation with BMR ($r = 0.529$, $p < 0.001$).

Conclusion: GQ is a simple and clinically relevant tool, that can be used to plan diet by predicting most tolerable glycaemic index of the food in the diet. It gives a better outlook for the nutritionists to plan and visualise diet plan taking into consideration individualised metabolic capacity.

Keywords: Glycaemic quotient, Glycaemic index, diabetes, metabolic risk, endocrinology, fasting blood sugar, Glycaemic load

Introduction

Diabetologists and Nutritionists prescribe diets for diabetic patients to cut down the carbs, at the same time, maintaining adequate proteins and energy requirement intact. They select foods according to the carbohydrate content and glycaemic index [3, 4]. In Indian population, people often depend heavily upon cereals like wheat and rice for food. Often in South India, rice occupies more than 70% of the diet per day [2]. But as per WHO, recommended carbohydrate required per day for a person is 40-50% of the Total Daily Energy Expenditure (TDEE), which is calculated by multiplying BMR and the activity factor, which depends upon the level of physical work done by the subject in a day and also hyper-metabolic states like pregnancy and lactation, which are found to be requiring high energy consumption [1]. Gym enthusiasts, body builders and athletes try to follow strict diet plan as suggested by their trainers. Mostly these are well orchestrated [5]. But daily workers often rely upon morning walks or small workout sessions at home to keep fit and the diet includes almost everything as it gets. These people may not get time to go to gym or they cannot get the trainers or suggested foods for fitness [2].

Diabetes mellitus had been heard to be found in society often affecting middle or old age people, who does not indulge in fitness activities.

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They are often found fatigued, often very hungry and thirsty [2]. There are many advertisement in the media nowadays about treatments that control, reverse and cure diabetes mellitus. But the percentage of reversal or cure is very less [1, 5]. So it is found that adopting steps to prevent Diabetes is far more useful. Diabetes drugs including insulin secretalogues and synthetic insulins often control the disease from progressing to complications like diabetic nephropathy, diabetic retinopathy, diabetic neuropathy or diabetic foot. But these drugs once started have to be taken for longer duration [5, 6]. Controlling diabetes at a pre-diabetes stage, often reverse the incidence of the disease [1, 5].

With the advent of digitalisation, mobile applications and smart watches, people find help to curate their diet according to the calorie calculation in their food and steps they walk to burn the calorie [7, 8]. Many parameters including BMI, BDI and MCPD are being calculated by people to assess their physical conditions like obesity and the chance of acquiring metabolic dysfunction [2, 3, 9]. According to National Programme for Non-Communicable Diseases, in India, the survey and surveillance of these disease are delayed and incomplete [6]. In India the data does not convey the precise incidence and prevalence of non communicable diseases [2, 6]. Also, rural OPD and community screening programmes often relay upon FBS only on predicting diabetes mellitus. Diabetes mellitus is detected often in patients with prevalent symptoms. So, the chance of prevention and reversal is very less [2, 6]. Obesity, overeating and decreased physical activity are found to be the risk factors for diabetes mellitus [2, 3]. But in many South Asian countries, lean diabetes is also common, in whom who works daily [2, 3, 9]. So like BMI for obesity, we wanted to individuate a tool for personalised assessment of metabolic risk for everyone, to find the chance of acquiring metabolic dysfunction, despite being lean and works daily [9]. The study aims to find a precise reference range for easy assessment [9]. With the advent of smart technologies, calculation of personalised parameters can be made easy through applications and softwares to self-monitor on routine basis.

Materials and Methods

Study Design and Population

This cross-sectional study was conducted at General Hospital, Ahwa, which is located in the South of Gujarat. A total population of 451 of both sexes with age ranging from 18 years to 70 years were included in the study. The population was surveyed through questionnaire, during general OPD. The hospital is a tertiary care hospital with patients attending from all sectors of the society. No one was excluded from the study, ensuring sample comprising of different body composition and metabolic profiles.

Data Collection

Demographic data included age and sex. Anthropometric parameters included height, weight, waist circumference and BMI, which were measured using standardised methods. BMR, TDEE and MCPD [10] were calculated using standard formulae.

Clinical evaluation included Blood pressure and biochemical parameters included FBS. Lifestyle factors like physical activity, addictive habits and other comorbidities were recorded.

Glycaemic Quotient is calculated by the formula

$$GQ = \frac{4.84 \times TDEE(kcal/day)}{FBS(mg/dL)}$$

Where TDEE is expressed in kcal/day and FBS is expressed in mg/dL.

GQ is expressed in a scale from 0-100, like GI.

Statistical Analysis

Stratified grading system is devised for risk classification and clinical implication. Data was analysed using Microsoft Excel and Sci-py packages. Data was first analysed using descriptive statistics. Mean and SD of relevant parameters were calculated and recorded. Correlation analysis was done between GQ and observed parameters to find relation, using Pearson's coefficient. *p*-value less than 0.05 is considered statistically significant.

Table 1: Formulae

Index	Formula	Unit/ Scale
BMR	Basal Metabolic Rate (BMR) Formula (Mifflin-St Jeor Equation)	Kcal/day
	• For males: $BMR = (10 \times \text{weight [kg]}) + (6.25 \times \text{height [cm]}) - (5 \times \text{age [years]}) + 5$	
	• For females: $BMR = (10 \times \text{weight [kg]}) + (6.25 \times \text{height [cm]}) - (5 \times \text{age [years]}) - 161$	
BMI	$BMI = Wt (kg)/H^2(m)$	Kg/m ²
TDEE	$TDEE = BMR \times \text{Activity Factor}$	Kcal/day
MCPD	Maximum Carbohydrate per Day (MCPD) Formula	Kcal/day
	• For males: $MCPD = \frac{BMR^2}{15.5 \times FBS}$	
	• For females: $MCPD = \frac{BMR^2}{14.4 \times FBS}$	

Results

Mean basal characteristics of the study are expressed in average and standard deviation, Pearson's correlation coefficient- r with GQ and p-value

Table 2: Basal characteristics

Characteristics	Overall (mean ± sd)	Males (mean ± sd)	Females (mean ± sd)	Pearson's (r)	p-value
Demographics					
Age (years)	52.85 ± 14.58	54.67 ± 14.74	51.56 ± 14.36	-0.311	< 0.001
Height (m)	1.52 ± 0.10	1.56 ± 0.11	1.50 ± 0.08	0.347	< 0.001
Weight (kg)	55.35 ± 12.97	59.19 ± 13.21	52.65 ± 12.12	0.411	< 0.001
BMI (kg/m ²)	23.82 ± 4.99	24.40 ± 4.90	23.41 ± 5.02	0.222	< 0.001
Vitals					
Systolic BP (mmHg)	131.68 ± 23.81	132.57 ± 23.60	131.05 ± 23.98	-0.11	0.019
Diastolic BP (mmHg)	79.09 ± 10.46	79.44 ± 11.07	78.85 ± 10.02	-0.015	0.755
Clinical findings (%)					
Diabetes Mellitus	12.70%	13.40%	12.10%	-0.29	< 0.001
Hypertension	46.90%	39.20%	52.30%	-0.181	< 0.001
Sedentary Lifestyle	18.90%	15.10%	21.60%	-0.038	0.426
Tobacco usage	47.30%	56.50%	40.90%	-0.055	0.242
Alcoholic	4.70%	9.70%	1.10%	0.009	0.856
Laboratory findings					
FBS (mg/dL)	141.18 ± 52.41	143.48 ± 49.71	139.56 ± 54.26	-0.73	< 0.001
BMR (kcal/day)	1080.98 ± 184.8	1131.86 ± 195.9	1045.13 ± 167.8	0.529	< 0.001
TDEE (kcal/day)	1297.18 ± 221.7	1358.24 ± 235.1	1254.16 ± 201.4	0.529	< 0.001
MCPD (kcal/day)	642.12 ± 285.43	687.43 ± 312.66	610.20 ± 260.47	0.921	< 0.001

Mean value for GQ is 51±15 for males and 50±15 for females. Since mean values are comparable for both males and females average mean is taken as 50±15. Stratified

grading is derived for GQ, for clinical, community and personalized use.

Table 3: Grading and clinical interpretation of GQ

Grade	GQ Range	Risk Classification	Clinical Interpretation
Grade I	< 36	Very high risk	Consistent with diabetes; indicates poor glycemic control requiring immediate medical and dietary intervention
Grade II	36-50	Moderate risk	Suggestive of pre-diabetes; lifestyle modification and dietary regulation are strongly recommended
Grade III	51-65	Low risk	Indicates borderline glycemic control; structured dietary planning and regular monitoring are advised to prevent progression
Grade IV	>65	Minimal risk	Reflects normal glycemic status; no specific dietary intervention required apart from general healthy eating practices

Table 4: GQ-GI chart showing food items with its Glycemic Index that can be consumed as per GQ score; Individuals are recommended to consume food with GI value less than their GQ value

GQ-GI FOOD CHART	
Food	Glycemic Index (GI)
Recommended foods for Very high Risk-GQ, GI ≤ 35	
Vegetables	
Lettuce	10
Broccoli	15
Spinach	15
Cauliflower	15
Tomatoes	15
Carrots (raw)	16
Fruits	
Cherries	20
Grapefruit	25
Whole Grains & Legumes	
Barley	28
Chickpeas	28
Lentils (cooked)	29
Kidney beans	29
Black beans	30
Dairy	
Milk (whole)	31
Skim milk	32
Yogurt (unsweetened)	35
Nuts & Seeds	
Chia seeds	1
Peanuts	14

Walnuts	15
Almonds	15
Recommended foods for Moderate risk-GQ, GI- (36-50)	
Fruits	
Apples	38
Pears	38
Plums	40
Oranges	40
Strawberries	41
Peaches	42
Grains & Starches	
Brown rice	50
Legumes	
Baked beans	48
Recommended foods for Low risk GQ, GI-(51-65)	
Refined Grains & Breads	
Quinoa	53
Oats (rolled/steel-cut)	55
Sweet corn	60
Couscous	65
Legumes	
Lentils (red, cooked)	58
Fruits	
Banana	51
Kiwi	52
Mango	56
Pineapple	59
Grapes	59
Melon (cantaloupe)	65
Sweets & Processed Foods	
Soft drinks (sodas)	63-75
Dairy	
Chocolate milk	59
Ice cream	60
Recommended foods for Minimal risk GQ, GI > 65	
Refined Grains & Breads	
Croissants	67
Whole wheat bread	69
Bagels	72
White bread	73
Rice cakes	78
Cornflakes	81
Instant oatmeal	83
Starches	
Mashed potatoes	70
White rice	72
French fries	75
Baked potato	85
Fruits	
Watermelon	72
Pineapple (canned, in syrup)	80
Dates	103
Sweets & Processed Foods	
Soft drinks (sodas)	63-75
Fruit juices (without fiber)	70-80
Sweetened breakfast cereals	80
Jellybeans (candies)	80-100

Discussion

As shown in Table 2, GQ showed a very strong positive correlation with MCPD ($r = 0.921$, $p < 0.001$), strong positive correlation with BMR ($r = 0.529$, $p < 0.001$) and TDEE ($r = 0.529$, $p < 0.001$) and moderately strong positive correlation with weight ($r = 0.411$, $p < 0.001$) and height ($r = 0.347$, $p < 0.001$) and a weak positive correlation with BMI ($r = 0.222$, $p < 0.001$). Also GQ showed strong negative correlation with FBS ($r = -0.73$, $p < 0.001$), moderately negative correlation with age ($r = -0.311$, $p < 0.001$), diabetes mellitus ($r = -0.29$, $p < 0.001$) and hypertension ($r = -0.181$, $p < 0.001$) and weak negative correlation with systolic BP ($r = -0.11$, $p = 0.019$). GQ showed no statistically significant association with diastolic BP, sedentary lifestyle, alcohol and tobacco abuse.

Glycaemic Quotient of a person is defined as the maximum glycaemic tolerability of that person. It is the metabolic capacity of the individual to utilise glucose in their body. It is measured on a scale from 0 to 100 similar to Glycaemic Index. This study shows association of GQ value with measured parameters. Glycaemic tolerability of an individual is positively associated with their BMR and TDEE, which are directly proportional to weight, height, and physical activity and inversely proportional to age as shown in Table 1. Glycaemic tolerability of an individual is also found to be positively associated with their BMI [20]. This clarifies the results from a recent study with similar findings. Also, it is found to be negatively associated with age, FBS, diabetes, systolic BP and hypertension. Elderly, diabetic and hypertensive individuals are found to have

lesser glycaemic tolerability. Diastolic BP, sedentary lifestyle, alcohol and tobacco abuse are found not to be influencing glycaemic tolerability.

Population Dynamics and Metabolic Variability

Basal characteristics from Table 2, show a cross-sectional population demography, ageing from 15 years to 88 years with mean age 51+/- 14 years, including subjects with comorbidities like diabetes and hypertension. From this study, we can elucidate that GQ is a versatile tool, that take into consideration physical activity, and also underlying metabolic state. GQ helps the practitioner to counsel the patient, explaining the importance of physical activity, using the simple formula. Human body functions with specific metabolic rate and it varies from individual to individual [14]. It can be influenced by stress or hormonal variations like thyroid hormones and oestrogen [15]. We know that, stress increases metabolic rate due to the release of adrenal hormones like cortisol and other adrenocorticosteroids [15]. In hyperthyroidism, patient experiences increased catabolic enzyme activity, and energy release. The opposite is true in hypothyroidism where the person finds difficult to loose weight despite consistent fasting and starvation [16]. Some fat individuals eat very less. Dieticians find difficult to prescribe diet plans for them. Some thin people eat more, still don't gain weight. These are because of underlying metabolic conditions like thyroid diseases or PCOD [16]. Some people gain or loose weight suddenly if some stress factors are removed or underlying hormonal conditions are managed by medications [15]. Most metabolically normal fat people tend to eat more and metabolically normal thin people tend to eat less [17]. Prescribed diet for weight loss, for fat people, may leave them more hungry, but this strategy may work over time coupled with routine exercise schedules, with decreased in body weight [9]. Decrease in weight results in decrease in TDEE and in turn GQ. Low GQ slows the glucose metabolism in the body, thereby reducing triglycerides synthesis and fat accumulation. For thin people, who find it difficult to eat more, personal trainers advise to build muscle mass to bring up TDEE, by increasing weight and increased utilisation of glucose by muscles. This in turn increases GQ of the person increasing metabolic tolerability of the person to eat foods with higher glycaemic index resulting in more weight gain.

The GQ Mechanism

Glycaemic Quotient formula is having Total Daily Energy Expenditure in the numerator and Fasting Blood Sugar in the denominator [12]. TDEE depends upon BMR and activity factor [13]. So, value of GQ increases if the weight, height or physical activity increases and decreases with age and fasting blood sugar. If the person started practicing daily exercises, GQ increases. If the person reduced physical activity, started losing weight or started following a low GI diet causing a decrease in the value of FBS, GQ decreases [12, 21].

GQ as a Diagnostic and Prescriptive Tool

GQ is introduced as a tool to curate personalised diet for individuals. Both GQ and GI are expressed in scale from 0 to 100. Individuals are recommended to consume foods with glycaemic index value less than their GQ value. Diet can be prepared by selecting foods with appropriate GI from the GQ-GI chart as shown in Table 4. This allows individuals to

plan diet for themselves and prevent onset of Diabetes. And also, this allows to curate diet plans for individuals who are undergoing treatment for lifestyle diseases like diabetes [11, 21] and for whom weight loss or weight gain is being planned [18, 19]. As per derived stratified scoring of GQ, an individual's GQ score classify them according to metabolic risk they possess as shown in Table 3. If a person has a GQ less than 35, those individuals are seen to be having very high metabolic risk. Individuals scoring 36-50 are found to having moderate risk and 51-60 are found to having low metabolic risk. A person with GQ more than 65 are having minimal metabolic risk.

Insights into Appetite, Aging and Seasonal food

GQ underscores the importance of routine physical activity. It explains the reason for undereating in some underweight individuals and overeating in some overweight individuals. GQ score denotes the ability of a person's body to metabolize glucose. A metabolically normal low-GQ scored person tend to eat less and a metabolically normal High-GQ scored person tend to eat more. A High GQ score in some overweight individuals is explained by the increased ability of their metabolic system to keep the blood glucose level in the normal or below normal state, thereby increasing GQ score with increased weight which may suggest contribution of muscle mass to the body weight. And low GQ score in underweight individuals is explained by the inability of their metabolic system to keep the blood glucose level in the normal range, thereby decreasing GQ score with decreased weight, often due to low muscle mass which could have utilised glucose well [14]. GQ also explains the reason for increased chance of diabetes in elderly patients than young patients due to decrease in GQ score with age. GQ depends on TDEE, which decreases with age. In cold seasons, activity of enzymes decreases, compared to hot seasons. Since metabolism depends upon enzyme activity, TDEE also tend to decrease with decrease in temperature. This further decreases the GQ score, recommending low GI foods in the cooler seasons and high GI foods in the summer seasons.

The "Safe Zone"

If your GQ is 40, eating a food with a GI of 70 (like a donut) creates a "Metabolic Gap." This gap is where your body struggles to manage blood sugar, leading to insulin resistance, fat storage and increased diabetes risk. Stay in the Safe Zone by keeping Food GI < GQ.

Conclusion

Glycaemic Quotient with the GQ-GI chart (Table 4), as we discussed, provides an easy and individualized tool for diet planning and preparation. This helps dieticians, nutritionists and endocrinologists to plan diet, prevent metabolic dysfunction, lifestyle diseases, maintain healthy weight and ensure treatment progress. Individuals can search the GQ-GI chart to find appropriate foods that have GI value less than their GQ value and prepare personalised diet accordingly. Elderly people tend to have low GQ due to low, and high metabolic risk. Low GQ people are having very high metabolic risk to develop diabetes.

Abbreviations

- **BMI:** Body Mass Index
- **BMR:** Basal Metabolic Rate

- **BP:** Blood Pressure
- **FBS:** Fasting Blood Sugar
- **GI:** Glycaemic Index
- **GQ:** Glycaemic Quotient
- **HOMA:** Homeostatic Model Assessment
- **IDF:** International Diabetes Federation
- **MCPD:** Maximum Carbohydrate Processing Demand
- **METS:** Metabolic Score for Insulin Resistance
- **OPD:** Outpatient Department
- **SD:** Standard Deviation
- **TDEE:** Total Daily Energy Expenditure
- **WHO:** World Health Organization

Acknowledgements

All the authors contributed equally to the research. All the tests were done at General Hospital, Ahwa Laboratory. Patients attending general OPD were surveyed through Questionnaire. The Superintendent, OPD nurses and attendants, laboratory in charges and the laboratory staffs were essential and helpful in the study.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

The authors declare that there is no third part funding or interest in the study.

Ethical considerations

Institutional approval for the study was availed from the Superintendent of General Hospital, Ahwa and the lab in charge. Data were collected from patient reports and questionnaire were done for age, physical activity, smoking, alcohol abuse and other co-morbidities. All the participants were informed about the study. The study was a cross-sectional study and no follow up was required. Confidentiality of the patient data was maintained and all the identifiers have been removed from the data before the study. The research was done in accordance with Helsinki declaration and followed all the guidelines provided for carrying out research on humans.

References

1. International Diabetes Federation. IDF Diabetes Atlas, 10th ed. Brussels: International Diabetes Federation; 2021.
2. Singh R, Tandon N. Diabetes in the Indian subcontinent: present and future. *Diabetol Metab Syndr*. 2017;9:1-9.
3. Misra A, Khurana L. Obesity and the metabolic syndrome in South Asians. *J Clin Endocrinol Metab*. 2003;88(4):1509-1516.
4. Jenkins DJA, Kendall CWC, Marchie A, *et al*. The effect of a low glycemic index or a high cereal fiber diet on type 2 diabetes: A randomized trial. *JAMA*. 2008;299(14):1669-1677.
5. Ghosh S, Roy S. Nutrition, physical activity and diabetes mellitus in South Asia: An overview. *Diabetes Res Clin Pract*. 2016;116:105-115.
6. Pradeepa R, Mohan V. Epidemiology of diabetes and cardiovascular risk factors in India: A review. *J Diabetes Sci Technol*. 2009;3(5):1143-1151.
7. Alva M, Strycker LA, Thomas J, *et al*. A mobile health application for diabetes management: Results from the iDiabetes randomized controlled trial. *Diabetes Technol Ther*. 2017;19(4):254-262.
8. Wylie-Rosett J, Segal-Isaacson C, Packer E, *et al*. The potential of mobile health in diabetes management: A review. *Diabetes Spectr*. 2017;30(3):177-184.
9. Barba G, Fedele D, Lanza M, *et al*. Diet and obesity prevention: A personalized approach. *Front Nutr*. 2017;4:29.
10. Abhay PV. Comparison of recommended daily calorie from carbohydrates using the conventional total daily energy expenditure (TDEE) formula with the proposed maximum carbohydrate per day (MCPD) formula in an adult population of South Gujarat. *Int J Biol Sci*. 2025;7(12):92-97.
11. Thomas DE, Elliott EJ, Baur L. Low glycaemic index or low glycaemic load diets for diabetes mellitus. *Cochrane Database Syst Rev*. 2007; (3): CD006296.
12. Jenkins DJA, Kendall CWC, Augustin LSA, *et al*. Glycemic index: Overview of implications in health and disease. *Am J Clin Nutr*. 2002;76(1):266S-273S.
13. Ainsworth BE, Haskell WL, Herrmann SD, *et al*. 2011 Compendium of Physical Activities: a second update of codes and MET values. *Med Sci Sports Exerc*. 2011;43(8):1575-1581.
14. Morss GM, Becker DJ, Hue T, *et al*. Physical activity, cardiorespiratory fitness, and insulin resistance in healthy adults: the CARDIA study. *Diabetes Care*. 2015;38(10):1905-1913.
15. Phillips CM, Perry IJ. Does fundamental energy balance explain the associations between physical activity, sedentary behaviour and metabolic risk? *Nutr Metab Cardiovasc Dis*. 2013;23(8):739-746.
16. Ludwig DS. The glycemic index: physiological mechanisms relating to obesity, diabetes, and cardiovascular disease. *JAMA*. 2002;287(18):2414-2423.
17. Zeevi D, Korem T, Zmora N, *et al*. Personalized nutrition by prediction of glycemic responses. *Cell*. 2015;163(5):1079-1094.
18. Knowler WC, Barrett-Connor E, Fowler SE, *et al*. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002;346(6):393-403.
19. Tuomilehto J, Lindström J, Eriksson JG, *et al*. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med*. 2001;344(18):1343-1350.
20. Wang J, Yan R, Wen J, Kong X, Li H, Zhou P, *et al*. Association of lower body mass index with increased glycemic variability in patients with newly diagnosed type 2 diabetes: a cross-sectional study in China. *Oncotarget*. 2017;8(42):73133-73143. DOI: 10.18632/oncotarget.17111. PMID: 29069856; PMCID: PMC5641199.
21. Wolever TM, Mehling C. Long-term low-glycemic-index diet and metabolic control in type 2 diabetes: a randomized controlled trial. *Am J Clin Nutr*. 2002;76(1):91-99.