Risk of developing type 2 diabetes mellitus among college students enrolled in Quezon City: A descriptive, cross-sectional study

Isaiah Kentz L. Calica, RMT[1]*, Roman Carlos R. Calingo[1], Luz Carissa E. Canlas[1], Maria Angelou D. Cantal[1], RCh, Pamela M. Comia[1], Joey Brianne C. Concepcion,[1] Hugh Marcel V. Cruz,[1] Jeanne Elaine T. Cruz,[1] Karla B. Cuerpo[1], and Araceli A. Panelo, MD, MS, FPCP[2]

Abstract

Introduction In 2021, the International Diabetes Federation, reported 536 million people with diabetes, mainly from countries with lower income.

Methods A cross-sectional descriptive study was employed using the Finnish Diabetes Risk Score (FINDRISC), a validated questionnaire which determines the risk of developing diabetes. The questionnaire was conducted online to be accomplished by students enrolled in universities located in Quezon City.

Results Among the 178 college students in Quezon City, with average age of 20 years old, 28.1% are at risk of developing T2DM. The factors contributing to the risk were: (1) Lack of physical activity of at least 30 minutes a day (51.7%); (2) lack of daily intake of vegetables and fruits or berries (52.8%); and (3) family history of DM (74.7%).

Conclusion The study found that one in every four college students in Quezon City is at risk of developing T2DM in the next ten years.

Key words: Diabetes mellitus, Type 2; FINDRISC; College students

The incidence and prevalence of type 2 diabetes mellitus (T2DM) and related deaths have been steadily increasing worldwide.[1,2] In 2014, the World Health Organization (WHO), reported 422 million people with diabetes, mainly from low- and middle-income countries including the Philippines. In 2014, there were at least 3.2 million cases of T2DM in the Philippines and 5.9% of those diagnosed were adults aged 20 to 79 years. After 7 years, the International Diabetes Federation (IDF) report showed that 10.5% of the global adult population has diabetes (approximately 537 million people).[2] Previously, T2DM was considered a disease of the middle-aged and elderly however, trends showed an increased incidence in younger individuals.[1] With this trend, prevention and early detection are keys to reducing the incidence of diabetes in this population. Establishment of the number of people at risk for developing T2DM is essential in planning effective prevention and control programs.[3]

College students are transitioning from adolescence to adulthood. At this stage, they are beginning to form

Correspondence: Isaiah Kentz L. Calica
Email: calicai5945@uerm.edu.ph
[1]College of Medicine, University of the East Ramon Magsaysay Memorial Medical Center, Inc.
[2]Department of Medicine, University of the East Ramon Magsaysay Memorial Medical Center, Inc.
*Presented in the Dr. Fernando S. Sanchez Jr. Research and Publication awardee, 24th Annual Research Forum, UERMMMCI Research Institute for Health Sciences, November 22, 2022

lifestyle choices including diet, physical activity influenced by their awareness of nutrition and well-being. Particularly, Asian college students have been found to have the greatest gap between perceived and actual risk of developing diabetes thus, it is in this age range that awareness of health risks and lifestyle modifications may be most beneficial to prevent diabetes. According to the International Diabetes Federation, the Finnish Diabetes Risk Score (FINDRISC) is a valid and inexpensive tool to use in resource limited settings for identifying individuals at high risk for T2DM.[4,5] Universities worldwide have conducted research using FINDRISC to determine the risk of developing T2DM among university students due to the increased prevalence of diabetes mellitus and/or obesity in their country. Findings of previous studies have concluded that influencing modifiable risk factors can significantly decrease the progression of T2DM in this population.[6,7]

Locally, there is lack of sufficient research on the determining the risk of developing T2DM among university students despite the increasing number of younger individuals being diagnosed with the condition. the objective of the study was to identify the risk of developing T2DM in university students, specifically by describing the proportion of students with and without the risk of developing T2DM.

Methods

The study was approved by the UERM Ethics Review Committee. A cross-sectional descriptive type of research design was utilized to determine the risk of college students in developing T2DM wherein the participants were categorized into those with risk and those without risk. The researchers recruited students currently enrolled in a bachelor program, from different colleges in Quezon City, who were able to understand English and who provided consent. Those who have a previous diagnosis of T2DM were excluded. Non- probability convenience sampling was employed, through online recruitment.

The sample size computation was based on a study conducted in Zamboanga, Philippines where 74.3% of the study sample was found to have slightly elevated to very high risk of developing T2DM.[8] The calculated sample size was 293.

The FINDRISC questionnaire was used in assessing the risk of the participants. It is a validated and reliable prediction tool (Cronbach's alpha of 0.84) developed to identify individuals at risk of developing T2DM. The FINDRISC questionnaire is validated for use in the Philippine setting, along with the modified FINDRISC and the simplified FINDRISC questionnaires.[9] The researchers retained the use of the FINDRISC questionnaire instead of the modified and simplified FINDRISC since the latter two omitted the physical activity and diet in the questionnaires. Literature review showed that physical activity and diet are important risk factors for T2DM in the younger population.[10] In the current study, only risk factors included were age, Basal metabolic index (BMI), waist circumference, use of blood pressure medication, physical activity, daily consumption of vegetables or fruits, history of high blood glucose and family history of diabetes.[4]

Data collection was conducted using an online questionnaire. Descriptive statistics were used to describe the demographic characteristics of the participants and present the risk of college students in developing diabetes. The participants were classified as either with risk or without risk based on the recommendations of the validity studies, in which a cut off score of 9 was found to be the most accurate and sensitive in screening Filipinos with dysglycemia when using the original FINDRISC questionnaire.[9]

Results

Of the 202 college students who answered the form online and underwent the screening process, 24 college students did not fit the inclusion criteria. Of the 178 eligible participants who completed the survey, 56 (31.5%) were males and 122 (68.5%) were females. The average age of the participants was 20 years old.

Table 1 shows the risk of developing T2DM among the participants, using the recommended cut-off value of 9 and above. More than one- fourth (28.1%) of the college students had a risk of developing T2DM.

Table 2 shows a breakdown of the components of the FINDRISC with the number of responses per

Table 1. Classification of risk of T2DM development among the participants (n = 178).

FINDRISC Classification	Total
Without risk (<9)	128 (71.9%)
With risk (≥9)	50 (28.1%)

possible option in the questionnaire. Selecting an option with a corresponding score of zero indicated the absence of risk, while selecting the other possible options indicated otherwise. Overall, there were three out of eight components wherein the zero-score options were not chosen by majority of the participants. This indicated that the majority of the college students in Quezon City have these risk factors. The components were as follows: physical activity (51.7% did not engage in physical activity at work or leisure); intake of vegetables, fruits or berries (52.8% did not eat vegetables, fruits or berries daily); and familial history of T2DM (51.1% have a grandparent, uncle, aunt or first cousin but no parent, brother, sister or child with T2DM).

After getting the FINDRISC score of each of the participants, they were separated into two categories based on the absence or presence of a risk. All participants regardless of risk were below 45 years of age.

The BMIs of the majority of the participants with risk (40%) were between 25 to 30 kg/m^2, as compared to the majority in those without risk (66.4%) and overall (55.1%) where it was less than 25 kg/m^2. The waist circumferences of the majority of the participants with risk (60%) were between 94 to 102 cm for the males and 80 to 88 cm for the females, as compared to the majority in those without risk (78.9%) and overall (64.6%) where it was below 94 cm for the males and 80 cm for the females.

Table 2. Frequency distribution of FINDRISC components among participants (overall and categories based on risk).

Age (years)				
<45 (0)		178 (100)	128 (100)	50 (100)
45-54 (2)		0	0	0
55-64 (3)		0	0	0
>64 (4)		0	0	0
BMI (kg/m^2)				
<25 (0)		98 (55.1)	85 (66.4)	13 (26)
25-30 (1)		58 (32.6)	38 (29.7)	20 (40)
>30 (3)		22 (12.4)	5 (3.9)	17 (34)
Waist Circumference (cm)				
Male	Female			
<94 (0)	<80 (0)	115 (64.6)	101 (78.9)	14 (28)
94-102 (3)	80-88 (3)	54 (30.3)	24 (18.8)	30 (60)
>102 (4)	>88 (4)	9 (5.1)	3 (2.3)	6 (12)
At least 30 minutes of physical activity daily				
Yes (0)		86 (48.3)	71 (55.5)	15 (30)
No (2)		92 (51.7)	57 (44.5)	35 (70)
Intake of vegetables, fruit or berries				
Everyday (0)		84 (47.2)	67 (52.3)	17 (34)
Not everyday (1)		94 (52.8)	61 (47.7)	33 (66)
History of high medication use blood pressure				
No (0)		164 (92.1)	122 (95.3)	42 (84)
Yes (2)		14 (7.9)	6 (4.7)	8 (16)
History of high blood glucose levels				
No (0)		166 (93.3)	127 (99.2)	39 (78)
Yes (5)		12 (6.7)	1 (0.8)	11 (22)
Family History of Diabetes Mellitus				
No (0)		45 (25.3)	42 (32.8)	3 (6)
Yes: second-degree relative, at most (3)		91 (51.1)	67 (52.3)	24 (48)
Yes: first-degree relative (5)		42 (23.6)	19 (14.8)	23 (46)

The majority in both those with risk (70%) and overall (51.7%) did not engage in at least 30 minutes of physical activity daily, as compared to the majority of those without risk (55.5%) who did. The majority in both those with risk (66%) and overall (52.8%) did not have daily vegetable, fruits or berries intake, as compared to the majority of those without risk (52.3%) who did have.

The majority did not have any history of high blood pressure medication (92.1%). Only 4.7% in those without risk and 16% in those with risk have used medications for high blood pressure. The same is true with regards to high blood glucose levels (93.3% did not have a history of being tested with high blood glucose levels). Only 0.8% in those without risk and 22% in those with risk had a history of having high blood glucose levels.

With regards to family history of diabetes mellitus (DM), the majority have relatives who were diagnosed with type 1 or type 2 DM (only 25.3% did not have relatives with DM). In the group without risk, 52.3% have second-degree relatives (but with no first-degree relatives) with DM and 14.8% have first-degree relatives with DM. In those with risk, 48% have second-degree relatives (but with no first- degree relatives) with DM and 46% have first-degree relatives with DM.

Discussions

Type 2 diabetes mellitus (T2DM) is a highly prevalent disease that is often undiagnosed until complications become apparent. Although adults and the elderly remain at a higher risk compared to young adults, evidence showed that T2DM is becoming more prevalent in young adults. It is projected to become predominant in many ethnic groups in the following years.[10,11,12] The increasing prevalence should be associated with an increasing risk of development to formulate ways to prevent acquisition of the disease. The risk of developing T2DM among college students was assessed using the FINDRISC questionnaire, which was already validated and found to be an effective tool in screening the risk for developing T2DM even in the Philippines.

In this study, the prevalence rate of the risk for developing T2DM in the next 10 years among college students in Quezon City (28.1%) was comparable to a previous study conducted in the Philippines wherein the overall prevalence of T2DM risk in the general population with mean age of 47 years old was 28.5%.[9] Obtaining a result close to the T2DM risk of the older population could imply that the present risk among college students should be of concern. In other countries, a similar study assessing the risk of developing T2DM in university students was done and results showed that prevalence of those with slightly elevated to high risk was at 33.2% indicating the same concern.[6]

The main driving force behind the increasing risk of developing T2DM in the younger population may be attributed to the increasing prevalence of sedentary lifestyles and obesity.[10] The sedentarism of college students can augment the burden of the increased risk of T2DM.[13,14] Sedentarism in this study encompassed an estimated 12 hours engaged in sedentary behaviors, as well as an increased daily sitting time and decreased physical activity during the pandemic.

The classification of the study participants as with risk or without risk using the FINDRISC questionnaire was based on the individual risk factors highly associated with T2DM. Among these risk factors considered were having a first- degree relative diagnosed with T2DM and having a history of high blood glucose during previous health examinations. In this study, only a fourth of the participants (23.6%) had a first-degree relative diagnosed with T2DM while very few (6.7%) had previously detected high blood glucose levels. Prominent risk factors found among college students were the lack of at least 30 mins of physical activity per day (51.7%), not consuming vegetables, fruits and berries daily (52.8%) and having a second-degree relative diagnosed with DM (51.1%).

Age

The mean age of the participants was 20 years old, and all were below 45 years old. The prevalence of T2DM and the risk for its acquisition remain higher in the elderly as compared to the younger population. In a 2016 study in China, it was found that adults from 55 to 74 years old were up to 7 times more likely to develop T2DM compared to when they were 20-34 years old.[15] Similarly, it was reported by the American Diabetes Association that T2DM rates remain higher in the elderly population.[16] This is attributed to the aging process itself or indirectly through age- related risk factors such as central obesity, mitochondrial dysfunction, free fatty acid and lipid metabolism disorders, inflammation,

beta-cell dysfunction, insulin resistance and metabolic syndrome.[17] Additionally, a different study on Chinese adults showed that, more than the metabolic risks, lifestyle factors, such as unhealthy sleeping patterns, played a bigger role in the development of DM in this age group.[18] In the Philippines, the mean age of diagnosing a new onset T2DM is 50 years old, which is close to the age at risk indicated in the FINDRISC questionnaire specified as 45 years old.[19] The study population consisted of individuals younger than 45 years old, suggesting no risk.

BMI and Waist Circumference

Being overweight or obese is heavily linked to T2DM by various mechanisms, two of which are insulin resistance and β-cell dysfunction.[20] Measuring the BMI of an individual and waist circumference can easily and non- invasively provide information regarding the risk of developing T2DM.

The BMI and waist circumference of the participants may be classified into different groups depending on different cut-off values, namely the Europoid-based cut-offs and the suggested cut-offs for Asia-Pacific. The FINDRISC questionnaire employed in this study uses the Europoid-based cut-offs and although Asia-Pacific cut-offs are preferred for the Filipino population, this would entail the use of a modified version of the questionnaire. The modified versions exclude the use of some risk factors, namely diet, physical activity, and even BMI. All of which are important factors to consider for the target population.[9,10] In the study, slightly more than a half (55.1%) of the participants had a BMI of less than 25 kg/m^2. This meant in turn that almost half (44.9%) of the students have a BMI of equal or more than 25 kg/m^2.

The waist circumference is a widely used measure of obesity in adults. It has been validated as a measure of overweightness and obesity in adolescents.[21] In this current study, more than half (64.6%) of the students have waist circumferences that fell within the normal expected values (below 94 cm for the males and 80 cm for the females). A greater proportion of the students had a waist circumference that indicated absence of risk. Approximately half of the participants have unfavorable anthropometric measurements. This is important since this risk factor is modifiable.

Physical Activity and Consumption of Fruit and Vegetables

Lifestyle modification through physical activity and diet has been widely recommended as part of the therapeutic regimen for patients diagnosed with diabetes mellitus. At least thirty minutes every day or 150 minutes total per week of moderate intensity exercises like brisk walking, could delay the progression of impaired glucose tolerance to overt diabetes. Physical inactivity may be associated with an increased risk of developing T2DM as noted in previous studies. In a study that stratifies participants into different degrees of risk (low, slightly elevated, moderate, and high risk), it was stated that having fewer participants with high risk may have resulted from half of their participants engaging in physical activity.[22] Similar to the results of this study, half of the participants engaging in physical activity may have played a part in a low proportion of the participants with risk.

A combination of physical activity and diet modification were said to achieve notable reduction in HbA1C levels.[23,24] Caloric restriction through dietary modification resulting in modest weight loss has been found to affect glycemic control and insulin sensitivity, especially in patients with hypertension or obesity. Studies suggest that both caloric restriction and weight loss could independently affect glycemic control, which may decrease the risk of developing T2DM.[25,26]

In addition, consumption of fruits and vegetables have protective effects against the progression of hypertension and cardiovascular diseases, which are conditions associated with developing diabetes. More than half of the total participants do not consume fruits and vegetables daily. Compared to the participants who have a good diet, those without could have a poorer outcome. Together with inactivity, these parameters could possibly contribute to the risk of developing T2DM.

Intake of Medications for High Blood Pressure

Individuals with poorly controlled blood pressure have a greater risk of developing diabetes. High blood pressure induces microvascular dysfunction, which may contribute to the pathophysiology of diabetes development.[27] Endothelial dysfunction is

related to insulin resistance, and hypertension since this constitutes a common ground for cardiovascular disease and T2DM.[28]

The findings in the study regarding antihypertensive medications as a risk factor for diabetes shows that the majority (92.1%) of the college students have not taken any high blood pressure medications. Only a few (7.9%) respondents also reported history of medication intake for high blood pressure. A study conducted on university students in Jordan demonstrates that majority (95.12%) of respondents did not take any medications for high blood pressure, while less than two percent of the total respondents had a history of taking medications in the past.[6] A noteworthy number of respondents have not taken any medication possibly due to the absence of increased blood pressure at the time of the study proper and lack of disease awareness.

In the Philippines, only 27% of hypertensive patients were aware of their hypertensive status. Asymptomatic subjects in lower social classes have undiagnosed hypertension. Policies and intervention trials that try to identify and modify risk factors are considered time-consuming for developing countries hampered by financial constraints. Hypertension among young people in Asian countries was said to be due to the interaction of environment, nutritional inadequacies, and genetics. Prevention efforts are burdened in developing Asian countries by the presence of other diseases and low community awareness of the dangers of cardiovascular diseases. The transition of developing Asian countries towards becoming an industrial market paves the way for consumers that impatiently seek affluent and indulgent lifestyles that affect their health.[29]

High Blood Glucose Levels

The increasing prevalence of diabetes in low to middle income countries puts a burden on both the healthcare system and individuals. The results of the study showed that majority of respondents (93.3%) had no high blood glucose at any instance in the past. However, 6.7% answered that they have had high blood glucose pointing to evidence that a high blood glucose level can also be seen in the younger age groups. These results showed that majority of respondents did not have any history of increased blood glucose, potentially due to absence of any risks,

lack of awareness and resources. These problems exist due to some gaps in the implementation of detection and treatment programs for diabetes.[30] A more pressing concern is the high cost of laboratory testing for comprehensive evaluation of diabetes, which is three to four times than the average daily earnings of a working Filipino. These out-of-pocket expenses make it hard for individuals to prioritize screening and diagnosis of comorbid conditions such as diabetes.[3]

Family History of Diabetes

This study found that majority of respondents reported that they had at least one first or second degree relative diagnosed with diabetes. A considerable number of respondents (23.6%) reported having first-degree relatives (parent, sibling, or child) with a diagnosis of T2DM. More than half of the respondents (51.1%) had a grandparent, uncle, aunt, or first cousin with diabetes. Almost the same number of study participants (25.3%) who said that they had first degree relatives with T2DM reported that they did not have a first or second-degree relatives with T2DM. The results of the study were comparable to a study conducted in Jordan wherein half of the total respondents (49.9%) mentioned having second degree relatives diagnosed with T2DM. There were fewer respondents (24.8%) who reported having first degree relatives diagnosed with T2DM.[6] Another study among young adult students in Nepal, showed that there were more respondents (38.5%) with second-degree relatives having T2DM, than respondents (21.8%) who have first-degree relatives diagnosed with T2DM.[31] Difference between studies may be attributed to the diverse interactions of environment, genes, and nutritional inadequacies in each country.[25] The relevance of family history in assessing the risk of developing diabetes is well established among various studies, however, there is no single explanation on the mechanism as to how positive family history of diabetes translates to an increased risk of developing diabetes.

The limitations in this study included not being able to achieve the desired sample size and having a sampling bias towards participants who have access to the internet and social media. Both of which reduced the internal validity of the results of the study. Additionally, the data collection was conducted during the COVID-19 pandemic but the study did not factor in

the effects of the pandemic to each of the risk factors of the participants, the FINDRISC score, and how it would impact the categorization of the individual into the groups of whether they were considered to have risk or not. The choice of the questionnaire also affected the interpretation of the results to a certain extent. The original FINDRISC questionnaire is validated for use for the Filipino population but it may not yet be considered the best data collection tool as it does not utilize the recommended cut-offs for the Filipino population specifically for the BMI and waist circumference parameters. Moreover, the questionnaire did not take into account other possible risk factors such as education and mental health conditions, which may also be contributory to the risk of developing T2DM.[32]

Conclusion

In a study involving 178 participants, it was found that one in every four (28.1%) college students in Quezon City was at risk of developing T2DM in the next 10 years. This is comparable to the prevalence rate of the risk for developing the condition in the general population which is at 28.5%; raising concerns since the student population mean age was 20 years old yet the risk is almost the same as that of the general population.

References

1. Diabetes [Internet] World Health Organization c2020. [cited 2021 May 27]. Available from: https://www.who.int/health-topics/diabetes
2. International Diabetes Federation. Diabetes Facts and Figures. [Internet]. Brussels: International Diabetes Federation; 2021. Available from: https://idf.org/about-diabetes/diabetes-facts-figures/
3. Tan GH. Diabetes Care in the Philippines. Ann Global Health 2016;81(6):863.
4. Lindstrom J, Tuomilehto J. The Diabetes Risk Score: A practical tool to predict type 2 diabetes risk. Diabetes Care 2003;26(3):725–31.
5. Diabetes Atlas, 9th Edition [Internet]. International Diabetes Federation. c2019 [cited 2021 May 27]. Available from: https://www.diabetesatlas.org/en/
6. Al-Shudifat AE, Al-Shdaifat A, Al-Abdouh AA, Aburoman MI, Otoum SM, Sweedan AG, Khrais I, Abdel-Hafez IH, Johannessen A. Diabetes Risk Score in a young student population in Jordan: A cross-sectional study. J Diab Res 2017;2017:8290710. doi: 10.1155/2017/8290710. Epub 2017 Apr 29.
7. Mongiello LL, Freudenberg N, Jones H, Spark A. Many college students underestimate diabetes risk. J Allied Health 2016 Summer; 45(2):81-6.
8. Shirinzadeh M. Type 2 diabetes mellitus risk and prevalence: a descriptive study in communities of the Zamboanga Peninsula, Philippines. [Unpublished manuscript]. 2021 [cited 2021 August3] Available from: http://hdl.handle.net/11375/25243
   Smith JA. Innovative approaches to data analysis. [Unpublished manuscript]. 2023 [cited 2024 Jun 03]. Available from: http://www.example.com/unpublished-paper
9. Ku GM, Kegels G. The performance of the Finnish Diabetes Risk Score, a modified Finnish Diabetes Risk Score and a simplified Finnish Diabetes Risk Score in community-based cross-sectional screening of undiagnosed type 2 diabetes in the Philippines. Prim Care Diab 2013 Dec;7(4):249-59. doi: 10.1016/j.pcd.2013.07.004. Epub 2013 Aug 15.
10. Song SH. Emerging type 2 diabetes in young adults. Adv Exp Med Biol 2012;771:51-61. doi: 10.1007/978-1-4614-5441-0_7.
11. Alberti G, Zimmet P, Shaw J, Bloomgarden Z, Kaufman F, Silink M. Type 2 diabetes in the young: The evolving epidemic. Diabetes Care 2004 Jul; 27(7): 1798-811. https://doi.org/10.2337/diacare.27.7.1798
12. Type 2 diabetes in children and adolescents. American Diabetes Association. Diabetes Care 2000 Mar;23(3):381-9. doi: 10.2337/diacare.23.3.381.
13. Moulin, MS. An Assessment of sedentary time among undergraduate students at an Urban Canadian University [Internet]. Electronic Thesis and Dissertation Repository 2016 [cited 2021Oct10] Available from: https://ir.lib.uwo.ca/etd/3699
14. López-Valenciano A, Suárez-Iglesias D, Sanchez-Lastra MA, Ayán C. Impact of COVID-19 pandemic on university students' physical activity levels: An early systematic review. Front Psychol 2021 Jan 15;11:624567. doi: 10.3389/fpsyg.2020.624567.
15. Yang L, Shao J, Bian Y, Wu H, Shi L, Zeng L, Li W, Dong J. Prevalence of type 2 diabetes mellitus among inland residents in China (2000-2014): A meta-analysis. J Diab Investig 2016 Nov;7(6):845-52. doi: 10.1111/jdi.12514. Epub 2016 Apr 27.
16. Statistics About Diabetes [Internet] American Diabetes Association c2020. [cited 2021 Oct 17]. Available from: https://www.diabetes.org/resources/statistics/statistics-about- diabetes?referrer=https%3A//www.google.com/
17. Suastika K, Dwipayana P, Semadi MS, Kuswardhani RA. Age as an important risk factor for type 2 diabetes mellitus and cardiovascular diseases. Glucose tolerance. Sureka Chackrewarthy. IntechOpen. 2012 December. doi: 10.5772/52397. Available from: https://www.intechopen.com/chapters/41385.
18. Wang T, Zhao Z, Wang G, Li Q, Xu Y, Li M, et al. Age-related disparities in diabetes risk attributable to modifiable risk factor profiles in Chinese adults: a nationwide, population-based, cohort study. The Lancet Healthy Longevity 2021;2(10).

19. Paz-Pacheco E, Jimeno C. Diabetes care in the Philippines. J ASEAN Fed Endocr Soc [Internet]. 2015Nov.30 [cited 2021Oct.17];30(2):118. Available from: https://www.asean- endocrinejournal.org/index.php/JAFES/article/view/267

20. Al-Goblan AS, Al-Alfi MA, Khan MZ. Mechanism linking diabetes mellitus and obesity. Diab Metab Syndr Obes. 2014 Dec 4;7:587-91. doi: 10.2147/DMSO.S67400.

21. Patnaik L, Pattnaik S, Rao EV, Sahu T. Validating neck circumference and waist circumference as anthropometric measures of overweight/obesity in adolescents. Indian Pediatr 2017 May 15;54(5):377-380. doi: 10.1007/s13312-017-1110-6. Epub 2017 Mar 29.

22. Sapkota M, Timilsina A, Shakya M, Thapa TB, Shrestha S, Pokhrel S, Devkota N, Pardhe BD. Metabolic syndrome and diabetes risk among young adult students in the health sciences from Kathmandu, Nepal. Drug Healthc Patient Saf 2020 Aug 17;12:125-133. doi: 10.2147/DHPS.S258331.

23. Umpierre D, Ribeiro PA, Kramer CK, Leitão CB, Zucatti AT, Azevedo MJ, Gross JL, Ribeiro JP, Schaan BD. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. JAMA 2011 May 4;305(17):1790-9. doi: 10.1001/jama.2011.576.

24. Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type 2 diabetes: a systematic review. Diabetes Care 2007 Mar;30(3):744-52. doi: 10.2337/dc06-1842.

25. Henry RR, Scheaffer L, Olefsky JM. Glycemic effects of intensive caloric restriction and isocaloric refeeding in noninsulin-dependent diabetes mellitus. J Clin Endocrinol Metab 1985 Nov;61(5):917-25. doi: 10.1210/jcem-61-5-917.

26. Wing RR, Blair EH, Bononi P, Marcus MD, Watanabe R, Bergman RN. Caloric restriction per se is a significant factor in improvements in glycemic control and insulin sensitivity during weight loss in obese NIDDM patients. Diabetes Care 1994 Jan;17(1):30-6. doi: 10.2337/diacare.17.1.30.

27. Suematsu C, Hayashi T, Fujii S, Endo G, Tsumura K, Okada K, Morii H. Impaired fasting glucose and the risk of hypertension in Japanese men between the 1980s and the 1990s. The Osaka Health Survey. Diabetes Care 1999 Feb;22(2):228-32. doi: 10.2337/diacare.22.2.228.

28. Kim M-J, Lim N-K, Choi S-J, Park H-Y. Hypertension is an independent risk factor for type 2 diabetes: The Korean genome and epidemiology study. Hypertens Res 2015;38(11):783–9.

29. Singh R, Suh I, Singh V, et al. Hypertension and stroke in Asia: Prevalence, control and strategies in developing countries for prevention. J Hum Hypertens 2000; 14: 749-63. 10.1038/sj.jhh.1001057.

30. Agarwal G, Guingona MM, Gaber J, Angeles R, Rao S, Cristobal F. Choosing the most appropriate existing type 2 diabetes risk assessment tool for use in the Philippines: a case-control study with an urban Filipino population. BMC Public Health 2019;19(1).

31. Sapkota M, Timilsina A, Shakya M, Thapa TB, Shrestha S, Pokhrel S, Devkota N, Pardhe BD. Metabolic syndrome and diabetes risk among young adult students in the health sciences from Kathmandu, Nepal. Drug Healthc Patient Saf 2020 Aug 17;12:125-133. doi: 10.2147/DHPS.S258331.

32. Boyko EJ, Jacobson IG, Smith B, Ryan MAK, Hooper TI, Amoroso PJ, et al. Risk of Diabetes in U.S. military service members in relation to combat deployment and mental health. Diabetes Care 2010; 33(8):1771– 7.