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Psychological Stress Is a Risk Factor for Type 2 Diabetes Mellitus in College Students

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Abstract Type 2 diabetes mellitus (T2DM) is multifactorial disease. This cross-sectional study was aimed to investigate relationship between stress and risk for T2DM in college students. Seven-hundred participants (350 T2DM risk and 350 non-T2DM risk groups). Stress index levels and heart rate variability (HRV) were respectively measured as primary and secondary outcomes. Results showed that both T2DM-risk and non-T2DM-risk groups had temporary stress, but the T2DM-risk group had significantly higher level of psychological stress ($P < .001$). For the HRV, the T2DM-risk group had significantly lower levels of parasympathetic proxies (lnHF, SDNN, and RMSSD) ($P < .001$). Chi-square (χ^2) test showed significant correlation of the stressful state with T2DM risk ($\chi^2 = 159.372$, $P < .001$, odds ratio (OR) = 9.326). In conclusion, psychological stress is a risk factor for T2DM in college students. Early detection, monitoring, and treatments of psychological stress should be implemented in this group of population.

Keywords Psychological stress, Type 2 diabetes mellitus, Young adulthood

1. Introduction

Type 2 diabetes mellitus (T2DM) is major non-communicable disease worldwide [2]. According to Clinical Practice Guideline (CPG) for Diabetes 2017 of the Diabetes Association of Thailand, risk score checklist for T2DM in Thai people has been developed based on advancing age, masculinity, family history, body mass index (BMI), central obesity, and hypertension [1]. Young adults (18-26 years old) are in a critical period in life as they have to think about their future career paths and economic security [12]. Hence, they are prone to depression, and psychological stress [8]. However, their needs during this transitional period were not concerned. Psychological stress might cause T2DM via stress hormone-induced insulin insensitivity [7]. This study investigated relationship between psychological stress and T2DM risk in young adult individuals by using a novel non-invasive technology device for stress index measurement on a fingertip.

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2. Methods

2.1. Study Design and Participants

Seven hundred college students from Mahasarakham University were recruited into this cross-sectional study. Inclusion criteria were being bachelor students and signed consent form. All procedures were approved by 2 reviewers of the Ethical Review Committee for Human Research, Mahasarakham University, and endorsed by the chairperson Dr.Ratree Sawangjit (No.276/2563). Exclusion criteria were psychiatric disease, metabolic disease, and recent major trauma. T2DM risk score was obtained from a checklist from the CPG [4]. The risk score was ranged from 0 - 17. The participants with score < 6 and ≥ 6 were divided into non-T2DM-risk and T2DM-risk groups (Table 1).

Table 1 Risk factors for T2DM and risk score

Risk factors for T2DM		Risk score
Age (years old)	34 – 39	0
	40 – 44	0
	45 – 49	1
	≥ 50	2
Sex	Female	0
	Male	2
Body mass index	< 23 kg/m^2	0
	23-27.4 kg/m^2	3
	≥ 27.5 kg/m^2	5
Waist circumference	Male < 90 cm, Female < 80 cm	0
	Male ≥ 90 cm, Female ≥ 80 cm	2
Hypertension	No	0
	Yes	2
Type 2 diabetes mellitus in first-degree relative	No	0
	Yes	4

2.2. Outcome Measurements

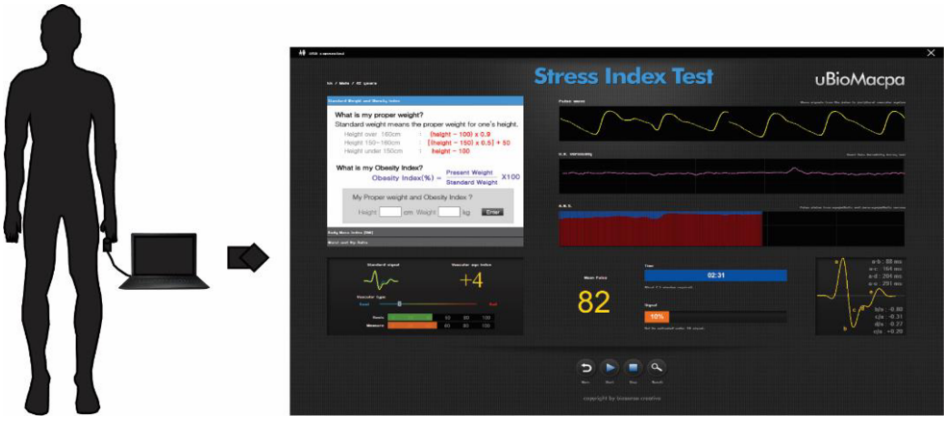

Figure 1 Non-invasive technology device for stress index measurement on a fingertip

Primary outcome (stress index) and secondary outcomes (HRV) were measured by photo-plethysmography (PPG) on the participant's left index finger tips connected to the uBioMacpa software as previously detailed [11] (Figure 1). The stress index scores were classified as 5 groups: no stress (< 25), temporary stress (25-34), primary stress (35-44),

accumulative stress (45-59), and chronic stress (≥ 60). The HRV parameters include sympathetic proxies [low frequency (lnLF) and low/high frequency ratio (LF/HF ratio)] and parasympathetic proxies [high frequency (lnHF), standard deviation of all normal R-R intervals (SDNN), and square root of the mean of the squared successive differences in R-R intervals (RMSSD)]. Statistical analyses were independent t-test and χ^2 test.

3. Results

3.1. T2DM-risk group had higher level of psychological stress

Both T2DM-risk and non-T2DM-risk groups had temporary stress, but T2DM-risk group had significantly higher level of psychological stress (P < .001). When further subdivided into the stressful subgroups (stress index ≥ 25), the T2DM-risk group had primary stress whilst the non-T2DM-risk group had temporary stress. Moreover, the T2DM-risk group also had statistically faster pulse rate. For the HRV, the T2DM-risk group had significantly lower lnHF, SDNN, and RMSSD (P < .001) (Table 2).

Table 2 Stress index and heart rate variability parameters in non-risk-T2DM and risk-T2DM

Parameter	Non-T2DM risk (n = 350)	T2DM risk (n = 350)	P-value
Stress index	25.20 ± 5.06	33.96 ± 8.06	<.001
Non-stressful	21.93 ± 2.37	22.37 ± 2.41	.25
Stressful	30.00 ± 4.03	35.79 ± 7.03	<.001
Pulse rate (beat/min)	76.59 ± 7.47	80.43 ± 10.99	<.001
lnLF (ms^2)	7.97 ± 0.61	8.57 ± 7.88	.16
lnHF (ms^2)	7.20 ± 0.48	6.93 ± 0.64	<.001
LF/HF ratio	1.11 ± 0.08	1.12 ± 0.09	.17
SDNN (ms)	65.74 ± 17.15	54.60 ± 23.34	<.001
RMSSD (ms)	51.25 ± 16.42	42.52 ± 23.09	<.001

3.2. Stressful State was Correlated T2DM Risk

Further analysis revealed that χ^2 test revealed that a stressful state was significantly correlated T2DM risk (χ^2 = 159.37, P < .001, OR = 9.32) (Table 3).

Table 3 Association between stress index and risk for T2DM

Stress index	T2DM risk (%)	Non-T2DM risk (%)	Total	χ^2	P-value	OR (95% CI)
Non-stressful	141 (40.29)	302 (86.29)	443	159.37	<0.001	9.32 (6.42-13.52)
Stressful	209 (59.71)	48 (13.71)	257			
Total	350	350	700			

4. Discussion and Conclusion

Risk for Type 2 Diabetes Mellitus in Transitional Age Youth (TAY): T2DM is caused by both genetic and non-genetic factors. The non-genetic factors consist of modifiable (physical activity, nutrition, smoking, alcohol drinking etc.) and non-modifiable factors (race, age, and sex etc.) [3]. Psychological stress is a modifiable factor causing T2DM in adults and elderly persons [5]. This present study was first to show a high psychological stress level in college students with high-risk score of T2DM. Age of the participants in this study (19-22 years old) is considered as TAY. An MRI study shows that prefrontal cortex (part of the brain for decision making) in TAY is still developing, implying stressful challenges of making decision in college students [6].

Possible Mechanisms of Psychological Stress-Induced Insulin Resistance in TAY: Psychological stress can be measured by psychological marker (stress questionnaire), biochemical marker (plasma cortisol), or physiological marker (HRV) [9]. Here we found that parasympathetic proxies of the HRV in the T2DM-risk group were lower than the non-T2DM-risk group. An increase in stress index in the T2DM-risk group might be due to reduced parasympathetic tone and increased sympathetic tone as shown by rapid pulse rate. Lastly, the participants with high stress index had 9 times greater likelihood of T2DM risk. Mechanisms of T2DM risk might be explained by psychological stress-induced insulin resistance via phosphorylated protein kinase B downregulation [10].

Conclusion: To conclude, psychological stress is a risk factor for T2DM in college students. Therefore, early detection, monitoring, and treatments of psychological stress should be implemented in this group of population.

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