TRENDS IN THE PREVALENCE OF TYPE 2 DIABETES AMONG ROYAL THAI ARMY PERSONNEL AND ASSOCIATED FACTORS FROM 2017 TO 2021

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Abstract

Background: Diabetes is one of the essential noncommunicable diseases associated with an increased risk of atherosclerosis and cardiovascular diseases. However, limited information is available regarding type 2 diabetes (T2D) among Royal Thai Army (RTA) personnel.

Objectives: The present study aimed to determine the prevalence of T2D among RTA personnel and its associated factors.

Methods: We carried out a serial cross-sectional study from 2017 to 2021. A total of 235,491 active-duty RTA personnel aged 35–60 years were included in the study. We defined T2D as fasting plasma glucose ≥126 mg/dL or having a history of T2D diagnosed by medical personnel, or having a history of taking antihyperglycemic medication. We used a multivariable logistic regression model to estimate adjusted prevalence ratios (APR) and 95% confidence intervals (CIs) for behavioral factors associated with T2D.

Results: Age- and sex-adjusted T2D prevalence among RTA personnel was 17.9% (95% CI 17.5%-18.2% in 2017 and then decreased to 16.5% (95% CI 16.1%–16.8%) in 2021 (p for trend < 0.001). The age-adjusted prevalence of T2D among males and females was 17.6 (95% CI 17.4%–17.8%) and 11.3 (95% CI 11.0%–11.7%), respectively. The independent behavioral factors associated with T2D included current cigarette smoking (APR 1.12; 95%CI 1.10-1.14), current alcohol use (APR 1.03; 95%CI 1.01-1.05), regular exercise (APR 0.89; 95%CI 0.87-0.90), body mass index ≥30 kg/m^2 (APR 2.21; 95%CI 2.15-2.27) and hypertension comorbidity (APR 3.97; 95%CI 3.88-4.05).

Conclusion: Our study indicated that T2D is a common health issue, especially among males, higher-aged participants and RTA personnel residing in Bangkok and the northeast. Cigarette smoking, alcohol use, and sedentary behavior played an essential role in the prevalence of T2D in this population. Furthermore, obesity and HT comorbidity were related to T2D.

Keywords: Diabetes, Hypertension, Body Mass Index, Prevalence, Associated factors

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Introduction

The World Health Organization indicated that noncommunicable diseases (NCDs) are estimated to account for 70% of the 57 million deaths worldwide, and one third of those comprise cardiovascular diseases.[1] Similarly, 74% of all deaths in Thailand were caused by NCDs and one fourth by cardiovascular diseases. [1] Diabetes, characterized by T2D, is one of the essential NCDs, a common health problem independently associated with an increased risk of atherosclerosis cardiovascular diseases (ASCVD).[2-6]

Diabetes is one of the most significant global health problems and exhibits a rising trend. The International Diabetes Federation (IDF) has estimated the global diabetes prevalence in 2019 to be 9.3% (463 million people), rising to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045.[1] In Thailand, the National Health Examination Survey (NHES) indicated that the prevalence of diabetes among Thai adults aged 15 years (who received a diagnosis of type 2 diabetes (T2D), had taken antihyperglycemic drugs or have fasting plasma glucose (FPG) 126 mg/dL) increased from 8.9% in 2014 (NHES V)[2] to 9.5% in 2019 (NHES VI).[1] Furthermore, approximately two thirds of Thai patients with T2D had hypertension (HT) as comorbidity[2], increasing the risk for its complications and ASCVD. [4]

Under the Royal Thai Army (RTA) of Thailand, males comprise approximately 90% of personnel aged 20 to 60. A recent study reported that behavioral risk for NCDs among RTA personnel was relatively high compared with that of the general Thai population; for example, obesity, a potential risk factor for T2D among RTA personnel, significantly rose over the rest of five years[4]. However, limited information remains available regarding the T2D situation and its factors associated with RTA personnel. Nationwide, approximately 50,000 RTA personnel aged at least 35 participate in yearly health examinations provided by the RTA Medical Department (RTAMED). The investigators aimed to determine T2D among RTA personnel using the physical health examination database available from 2017 to 2021.

Methods

Study Design and Subjects

RTA personnel's physical health examination database is available from 2017 to 2021. Therefore, to explore the trends in T2D prevalence, we carried out a serial cross-sectional study from 2017 to 2021. The dataset was retrieved from RTA personnel's annual health examination database after obtaining permission from the RTAMED in Bangkok, Thailand. Therefore, the study design and subjects in the present study were explained using established methods from the recent related study of Sakboonyarat et al.[4,5] The RTAMED provides annual health examinations for RTA personnel through the Armed Forces Research Institute of Medical Sciences; the Army Institute of Pathology and Phramongkutklao Hospital located in the Bangkok Metropolitan Area and 36 RTA hospitals nationwide, including ten RTA hospitals in central, ten in northeastern, ten in northern and six in southern Thailand. The data of health examinations were reported to the RTAMED in Bangkok.

The inclusion criteria for this study included active-duty RTA personnel aged 35 to 60 years nationwide. Because we used the collected data, the data for RTA personnel not participating in each annual health examination were excluded from the data for that year. In the present study, we proposed to determine the prevalence of T2D; thus, the RTA personnel not having a record of FPG level in their data were excluded. Finally, 235,491 RTA personnel from 2017 to 2021 were eligible.

Data Collection

A self-report guide was conducted using a standardized case report form for obtaining demographic characteristics and behavioral risk factors, including age, sex, health scheme, smoking status, alcohol use and regular exercise. Moreover, information on comorbidities was also collected including the history of HT and T2D. A history of T2D and a history of HT were defined using the data from the responses to the following questions:[1] "Have you ever received a diagnosed of T2D or taken antihyperglycemic drugs?"

and[2] "Have you ever received a diagnosis of HT or taken antihypertensive drugs?" Behavioral factors were defined using data from the responses to the questionnaire. Current alcohol consumption and smoking were defined as having a history of consuming alcohol and cigarette smoking within 12 months.[6, 7] Regular exercise was defined as exercising 30 min/day and at least three days/week.[8]

The annual health examination dataset also included anthropometric measurements of weight, height, systolic blood pressure (SBP), diastolic blood pressure (DBP) and laboratory data including FPG. Blood pressure (BP) was measured using an automatic blood pressure monitor by an operator trained in the standardized technique according to the Thai guidelines on treating HT.[9] We defined T2D as FPG ≥126 mg/dL, having a history of T2D diagnosed by medical personnel or taking antihyperglycemic medication.[10] HT comorbidity was defined by a systolic blood pressure (SBP) ≥140 mmHg, a diastolic blood pressure (DBP) ≥90 mmHg, a history of HT diagnosed by medical personnel or a history of taking antihypertensive medication.[9] Body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared: $(kg)/(m)^2$. BMI was classified in five groups according to the Asia-Pacific perspective, including underweight (<18.50 kg/m^2), normal (18.50 to 22.99 kg/m^2), overweight (23.00 to 24.99 kg/m^2), obese I (25.00 to 29.99 kg/m^2) and obese II (≥30.00 kg/m^2).[11]

Statistical Analysis

All statistical analyses were performed using StataCorp. 2021, Stata Statistical Software: Release 17 (College Station, TX: StataCorp LLC). We calculated the frequency distribution of demographic characteristics and behavioral factors to describe the study subjects. Categorical data such as sex, age categories, regions, health schemes, smoking status, alcohol consumption, regular exercise, BMI categories, FPG categories, history of T2D and HT comorbidity were presented as percentages. Continuous variables including age, BMI and FPG were presented as mean and standard deviation (SD). We calculated the prevalence of T2D and presented it as a percentage with a 95% confidence interval (CI). P for trend was calculated using regression to test the statistical significance of trends in the prevalence of T2D from 2017 to 2021. The nonlinear trend was tested first by adding a quadratic term to the regression model. If the result was not significant, a linear trend was tested. We performed a univariable analysis to determine the association between associated factors and the prevalence of T2D. A multivariable logistic regression model was used to determine the factors associated with T2D. The variables that were significant in univariable analysis were recruited in the final model including sex, age, region, scheme, smoking status, alcohol consumption, regular exercise, BMI categories, HT comorbidity and year. After running a logit model, the adjrr (margin) command was used to calculate the adjusted prevalence ratio (APR), which presented a corresponding 95% CI. A two-sided *p*-value less than 0.05 was considered statistically significant.

Ethics Considerations

The study was reviewed and approved by the Institutional Review Board, Royal Thai Army Medical Department (approval number S067h/64 & S056h/65) in compliance with international guidelines including the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use-Good Clinical Practice (ICH-GCP). Due to the use of secondary data, a waiver of documentation of informed consent was employed. The Institutional Review Board, Royal Thai Army Medical Department approved the informed consent waiver.

Results

Characteristics of Participants

Table 1 shows the demographic characteristics of 253,491 RTA personnel from 2017 to 2021. In all, approximately 90% of RTA personnel were males. The mean age of study participants ranged from 46.7 to 48.0 years. Almost two fifths of participants resided in central regions.

The prevalence of current smokers continuously increased from 24.6% in 2017 to 28.4% in 2021. The average FPG of study participants was 103.4±36.0 mg/dL in 2017, then rose to 105.1± 39.5 mg/dL in 2019 and decreased to 102.5±32.7 mg/dl in 2021. Totally, 14.5% of participants reported a history of T2D in 2017 dropping to 12.3% in 2021. In all, approximately 40% of study participants had HT comorbidity.

Table 1. Demographic characteristics of participants from 2017-2021

Year Characteristics	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	2021 n (%)
No. of participants	39,899	45,626	51,208	53,004	45,754
Sex					
Male	36257 (90.9)	40567 (88.9)	45845 (89.5)	46559 (87.8)	41270 (90.2)
Female	3642 (9.1)	5059 (11.1)	5363 (10.5)	6445 (12.2)	4484 (9.8)
Age (years)					
mean±SD	48.0±7.1	47.6±7.3	47.4±7.5	47.5±7.7	46.7±7.7
35-39	6781 (17.0)	8551 (18.7)	10338 (20.2)	11378 (21.5)	11517 (25.2)
40-44	7354 (18.4)	9149 (20.1)	9990 (19.5)	9513 (17.9)	8338 (18.2)
45-49	6301 (15.8)	7230 (15.8)	7911 (15.4)	8732 (16.5)	7927 (17.3)
50-54	9947 (24.9)	10022 (22.0)	10453 (20.4)	9582 (18.1)	7562 (16.5)
≥55	9516 (23.9)	10674 (23.4)	12516 (24.4)	13799 (26.0)	10410 (22.8)
Regions					
Bangkok	7320 (18.3)	9949 (21.8)	10906 (21.3)	11139 (21.0)	5552 (12.1)
Central	15220 (38.1)	17423 (38.2)	19159 (37.4)	19760 (37.3)	18358 (40.1)
Northeast	7238 (18.1)	7550 (16.5)	8508 (16.6)	9994 (18.9)	7660 (16.7)
North	7413 (18.6)	5386 (11.8)	7401 (14.5)	6740 (12.7)	8674 (19.0)
South	2708 (6.8)	5318 (11.7)	5234 (10.2)	5371 (10.1)	5510 (12.0)
Scheme					
Civil servant medical benefit	38977 (97.7)	44736 (98.0)	50290 (98.2)	51466 (97.1)	44999 (98.3)
Social Security	576 (1.4)	430 (0.9)	489 (1.0)	1124 (2.1)	646 (1.4)
Universal Coverage	346 (0.9)	460 (1.0)	429 (0.8)	414 (0.8)	109 (0.2)
Smoking status					
Never	22333 (56.7)	26064 (57.9)	27270 (54.7)	25296 (50.1)	23601 (51.7)
Ex-smoker	7322 (18.6)	6865 (15.2)	9324 (18.7)	10597 (21.0)	9099 (19.9)
Current smoker	9720 (24.7)	12122 (26.9)	13295 (26.6)	14645 (29.0)	12966 (28.4)
Alcohol consumption					
Never	10318 (26.3)	12267 (27.3)	12735 (25.0)	10692 (21.2)	11661 (25.5)
Ex-drinker	3850 (9.8)	4421 (9.8)	5479 (10.7)	6069 (12.0)	5415 (11.9)
Current drinker	25132 (63.9)	28303 (62.9)	32780 (64.3)	33771 (66.8)	28565 (62.6)
Regular exercise					
No	16683 (42.6)	18604 (42.3)	18578 (37.3)	23609 (45.1)	20432 (44.8)
Yes	22446 (57.4)	25397 (57.7)	31293 (62.7)	28707 (54.9)	25146 (55.2)
Body mass index (kg/m^2)					
mean±SD	25.1±3.6	25.2±3.7	25.3±3.7	25.3±3.7	25.3±3.8
18.50-22.99	10512 (26.3)	11759 (25.8)	13039 (25.5)	13705 (25.9)	11656 (25.5)
<18.50	657 (1.6)	656 (1.4)	698 (1.4)	725 (1.4)	621 (1.4)
23.00-24.99	10076 (25.3)	11467 (25.1)	12992 (25.4)	13279 (25.1)	11482 (25.1)
25.00-29.99	15071 (37.8)	17358 (38.0)	19355 (37.8)	19835 (37.4)	17037 (37.2)

Table 1. Demographic characteristics of participants from 2017-2021 (Cont.)

Year Characteristics	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	2021 n (%)
No. of participants	39,899	45,626	51,208	53,004	45,754
≥30.00	3583 (9.0)	4386 (9.6)	5124 (10.0)	5460 (10.3)	4958 (10.9)
Fasting plasma glucose (mg/dL)					
mean±SD	103.4±36.0	104.0±36.8	105.1±39.5	103.0±33.9	102.5±32.7
<100	26033 (65.2)	29451 (64.5)	32857 (64.2)	34928 (65.9)	30522 (66.7)
100-125	9844 (24.7)	11580 (25.4)	12607 (24.6)	12857 (24.3)	10929 (23.9)
≥126	4022 (10.1)	4595 (10.1)	5744 (11.2)	5219 (9.8)	4303 (9.4)
History of type 2 diabetes					
No	34110 (85.5)	40294 (88.3)	45140 (88.2)	46117 (87.0)	40145 (87.7)
Yes	5789 (14.5)	5332 (11.7)	6068 (11.8)	6887 (13.0)	5609 (12.3)
Hypertension comorbidity					
No	22815 (57.2)	27265 (59.8)	31149 (60.8)	31752 (59.9)	26931 (58.9)
Yes	17084 (42.8)	18361 (40.2)	20059 (39.2)	21252 (40.1)	18823 (41.1)

Prevalence of Type 2 Diabetes among RTA Personnel from 2017 to 2021

Table 2 presents the prevalence of T2D among RTA personnel from 2017 to 2021. Age- and sex-adjusted T2D prevalence among RTA personnel was 17.9% (95% CI 17.5 to 18.2% in 2017 and then decreased to 16.5% (95% CI 16.1 to 16.8%) in 2021 (*p* for trend <0.001) (**Figure 1)**. The age-adjusted prevalence of T2D among males and females was 17.6 (95% CI 17.4 to 17.8%) and 11.3 (95% CI 11.0 to 11.7%), respectively. **Figure 2** shows the prevalence of T2D stratified by age group and sex. Age- and sex-adjusted prevalence of T2D among RTA personnel residing in Bangkok, the north and northeast tended to increase (*p* for trend <0.001).

Factors Associated with Type 2 Diabetes

The APR from the multivariable logistic regression model is shown in **Table 3.** The independent behavioral factors associated with T2D included current cigarette smoking (APR 1.12; 95%CI 1.10 to 1.14), current alcohol use (APR 1.03; 95%CI 1.01 to 1.05), regular exercise (APR 0.89; 95%CI 0.87 to 0.90), body mass index 30 kg/m^2 (APR 2.21; 95%CI 2.15 to 2.27) and hypertension comorbidity (APR 3.97; 95%CI 3.88 to 4.05).

Discussion

This study represented the extensive epidemiologic study of T2D prevalence among RTA personnel in Thailand for over five years. Regarding the NHES VI in 2019, the prevalence of T2D, using a similar definition to the present study, among Thai adults 15 years was 9.5%.[1] Compared with the NHES VI, the overall T2D prevalence among RTA personnel was higher (18.4%); however, the present study included participants aged 35 to 60 years. In addition, this finding may be explained by the difference in the behavioral factors, which were established to be at risk for T2D, including a higher prevalence of history of alcohol consumption (70%) and higher obesity prevalence among RTA personnel compared with the study participants in the NHES VI.[1] On the other hand, we found that decreasing trends in the prevalence of T2D among RTA personnel slightly dropped from 17.9% in 2017 to 16.5% in 2021. Although this trend was statistically significant, extended study participants may have caused it. T2D prevalence in this population remains relatively high. Conversely, the NHES V in 2014[12] and VI in 2019 [1] demonstrated that the overall prevalence of T2D among Thai adults slightly rose from 8.9 to 9.5% over five years.

We found that the prevalence of T2D among male participants was significantly higher than

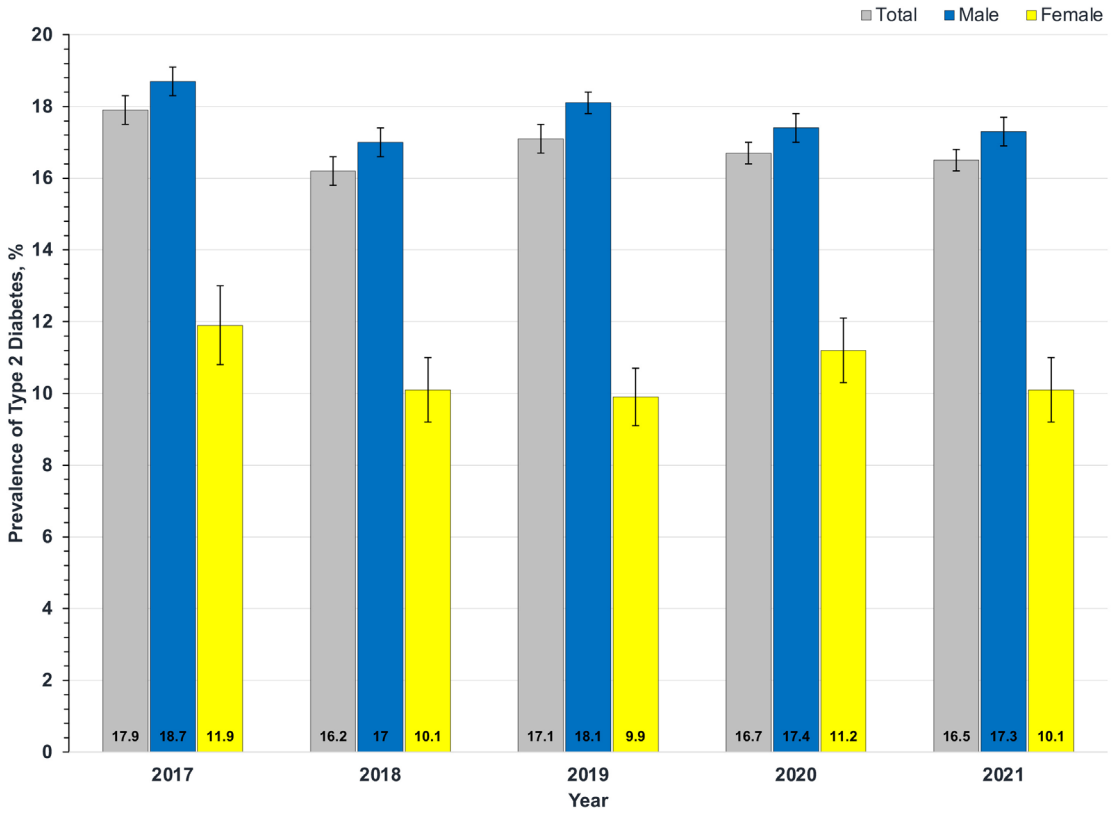

Figure 1. Trends in the age- and sex-adjusted prevalence of type 2 diabetes and 95% CI from 2017 to 2021; sex-specific prevalence (age-adjusted)

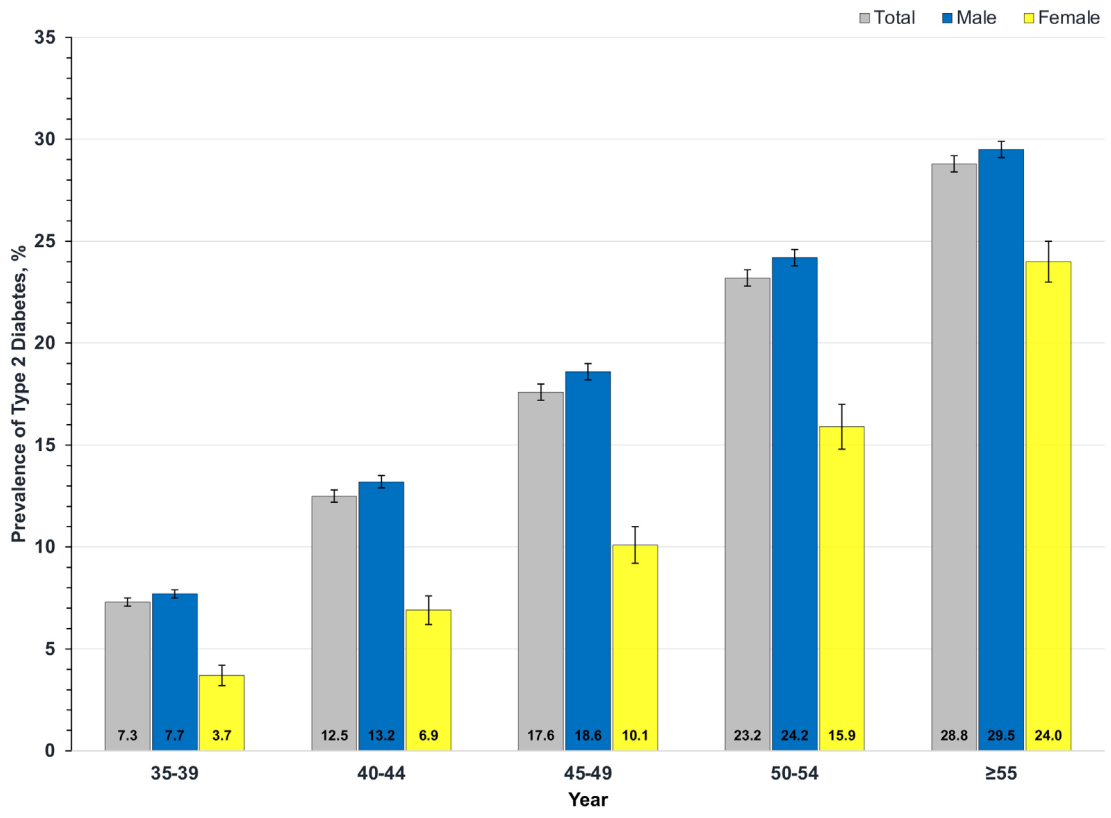

Figure 2. Prevalence of type 2 diabetes and 95% CI, stratified by age and sex

Table 2. Prevalence of type 2 diabetes among Royal Thai Army personnel from 2017-2021

Characteristics	Overall (n=235,491)		2017 (n=39,899)		2018 (n=45626)		2019 (n=51208)		2020 (n=53004)		2021 (n=45754)		*p*-for trend
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	
Total [a]	18.4	18.3-18.6	17.9	17.5-18.2	16.2	15.8-16.5	17.1	16.8-17.5	16.7	16.3-17.0	16.5	16.1-16.8	0.001†
Sex [b]													
Male	17.6	17.4-17.8	18.7	18.3-19.1	17.0	16.6-17.3	18.1	17.8-18.5	17.4	17.0-17.7	17.3	16.9-17.7	0.001†
Female	11.3	11.0-11.7	11.9	10.9-13.0	10.1	9.4-11.0	9.9	9.1-10.7	11.2	10.5-12.0	10.1	9.2-11.0	0.218‡
Age (years) [c]													
35-39	7.3	7.0-7.5	9.0	8.3-9.7	6.8	6.3-7.4	7.8	7.3-8.3	6.5	6.1-7.0	6.5	6.0-6.9	<0.001†
40-44	12.5	12.2-12.8	13.6	12.8-14.4	11.5	10.9-12.2	13.0	12.4-13.7	11.5	10.9-12.2	12.4	11.7-13.1	0.061‡
45-49	17.6	17.2-18.0	18.4	17.5-19.4	16.3	15.5-17.2	17.9	17.0-18.7	17.3	16.5-18.1	17.4	16.6-18.2	0.554‡
50-54	23.2	22.8-23.6	24.2	23.3-25.0	22.2	21.4-23.0	23.4	22.6-24.2	23.3	22.5-24.2	23.2	22.2-24.1	0.538‡
≥55	28.8	28.4-29.2	29.0	28.1-29.9	28.4	27.5-29.2	28.5	27.7-29.3	29.7	29.0-30.5	28.6	27.7-29.5	0.557‡
Regions [a]													
Bangkok	17.0	16.7-17.4	17.3	16.4-18.2	16.0	15.3-16.7	16.8	16.1-17.6	18.0	17.2-18.7	18.4	17.4-19.4	<0.001†
Central	16.9	16.6-17.1	20.1	19.4-20.7	16.6	16.1-17.2	17.7	17.2-18.3	16.1	15.6-16.6	15.3	14.8-15.9	<0.001†
Northeast	17.2	16.9-17.6	16.8	16.0-17.7	17.1	16.3-18.0	18.4	17.5-19.2	17.7	16.9-18.4	19.8	18.9-20.7	<0.001†
North	18.3	17.9-18.7	17.0	16.2-17.8	16.5	15.5-17.5	18.0	17.2-18.9	18.5	17.5-19.4	18.6	17.7-19.4	0.001†
South	13.4	13.0-13.9	13.1	11.9-14.3	13.0	12.2-13.9	12.6	11.8-13.5	11.9	11.1-12.8	10.0	9.2-10.9	<0.001†

95% CI: 95% confidence interval, †Nonlinear trend was tested first by adding a quadratic term into the regression model. If not significant, linear trend was tested., ‡Linear trend, [a]age- and sex- adjusted prevalence, [b]age-adjusted prevalence, [c]sex-adjusted prevalence

Table 3. Factors associated with type 2 diabetes among Royal Thai Army personnel

Factors	Unadjusted Prevalence Ratio	95% CI	*p*-value	Adjusted Prevalence Ratio	95% CI	*p*-value
Sex						
Female	1			1		
Male	1.50	1.45-1.55	<0.001	1.11	1.07-1.15	<0.001
Age (years)						
35-39	1			1		
40-44	1.71	1.65-1.79	<0.001	1.45	1.40-1.51	<0.001
45-49	2.41	2.32-2.51	<0.001	1.84	1.77-1.91	<0.001
50-54	3.19	3.08-3.31	<0.001	2.24	2.16-2.31	<0.001
≥55	3.95	3.81-4.09	<0.001	2.60	2.52-2.69	<0.001
Regions						
Bangkok	1			1		
Central	0.96	0.93-0.98	<0.001	0.90	0.88-0.92	<0.001
Northeast	1.01	0.98-1.04	0.515	0.91	0.89-0.93	<0.001
North	0.99	0.97-1.02	0.697	0.95	0.93-0.98	<0.001
South	0.71	0.69-0.74	<0.001	0.74	0.72-0.77	<0.001
Health insurance scheme						
Civil servant medical benefit	1				1	
Social Security	0.84	0.77-0.91	<0.001	1.03	0.96-1.11	0.462
Universal Coverage	0.72	0.63-0.81	<0.001	0.83	0.75-0.92	<0.001
Smoking status						
Never	1			1		
Ex-smoker	1.36	1.33-1.38	<0.001	1.15	1.13-1.17	<0.001
Current smoker	1.08	1.06-1.10	<0.001	1.12	1.10-1.14	<0.001
Alcohol consumption						
Never	1			1		
Ex-drinker	1.33	1.29-1.37	<0.001	1.17	1.14-1.20	<0.001
Current drinker	1.15	1.12-1.17	<0.001	1.03	1.01-1.05	0.010
Regular exercise						
No	1			1		
Yes	0.85	0.83-0.86	<0.001	0.89	0.87-0.90	<0.001
Body mass index (kg/m^2)						
18.50-22.99	1			1		
<18.50	0.91	0.81-1.01	0.090	0.95	0.86-1.05	0.275
23.00-24.99	1.48	1.44-1.53	<0.001	1.26	1.22-1.29	<0.001
25.00-29.99	2.16	2.10-2.22	<0.001	1.57	1.53-1.61	<0.001
≥30.00	3.46	3.36-3.56	<0.001	2.21	2.15-2.27	<0.001
Hypertension comobidity						
No	1			1		
Yes	5.25	5.14-5.37	<0.001	3.97	3.88-4.05	<0.001

Table 3. Factors associated with type 2 diabetes among Royal Thai Army personnel (Cont.)

Factors	Unadjusted Prevalence Ratio	95% CI	*p*-value	Adjusted Prevalence Ratio	95% CI	*p*-value
Year						
2017	1			1		
2018	0.88	0.86-0.91	<0.001	0.94	0.92-0.96	<0.001
2019	0.93	0.91-0.96	<0.001	0.99	0.97-1.01	0.384
2020	0.91	0.89-0.93	<0.001	0.95	0.92-0.97	<0.001
2021	0.87	0.84-0.89	<0.001	0.91	0.89-0.94	<0.001

Multivariable model included sex, age, regions, health scheme, smoking status, alcohol consumption, regular exercise, body mass index, hypertension, and year
95% CI: 95% confidence interval

that among females in all age groups between 35 and 60 years which was in line with the recent report from the IDF Atlas in 2019.[13] However, the NHES VI in 2019 represented that T2D prevalence among Thai men aged 30 to 44 years was higher than that among women, whereas, among adults aged 45 to 59 years, females revealed a higher prevalence of T2D than males.[1] We found that RTA personnel residing in Bangkok were more likely to have T2D than those residing in other regions, consistent with the findings from the NHES VI [1]. This phenomenon may be explained by the recent evidence that the RTA personnel in Bangkok tended to have a higher prevalence of obesity than those in other regions.[4]

Our finding indicated a dose-response relationship between the age of study participants and T2D prevalence among both males and females. This finding agreed with the related study in Thailand[14] and the IDF Atlas in 2019.[13] The established evidence can explain this finding that aging directly affects the decline of β-cell function and contributes indirectly to impaired insulin sensitivity through lifestyle-related and comorbidity-related risk factors.[15, 16] Our results suggest that the high prevalence of T2D among RTA personnel, especially in higher-age individuals, should be recognized and provided appropriate management, such as aligning approaches to diabetes management with the Chronic Care Model.[17, 18]

Cigarette smoking is a known independent behavioral risk factor for T2D.[19-23] Similarly, we observed that RTA personnel reporting former and current smoking tended to have higher T2D prevalence than those who never smoked. Furthermore, we also found that the prevalence of current smoking in the present study (24.7 to 29.0%) was higher than that among Thai adults (18.7%) reported in the NHES VI.[1] Therefore, cigarette smoke may significantly contribute to T2D among RTA personnel. Our study suggests that advising to discontinue cigarette smoking and providing tobacco cessation support should be incorporated during annual physical health examinations.[24]

Our study demonstrated that the T2D prevalence among study participants who consume alcohol was higher when compared with that among abstainers. Similarly, the Atherosclerosis Risk in Communities Study also indicated an increased risk of T2D was observed among men consuming >21 drinks/week compared with men consuming ≤1 drink/week (AOR 1.50; 95% CI 1.02 to 2.20).[25] In contrast, a large population-based cohort study in Denmark reported that consuming alcohol over three to four days weekly is associated with the lowest risk of diabetes compared with consuming <1 day/week.[26] However, the existing evidence demonstrated that chronic use of alcohol is considered a potential risk factor for T2D, for which several mechanisms, such as defective glucose tolerance and decreased insulin sensitivity among individuals with chronic alcohol use, may explain.[27,28]

Our finding also indicated that the prevalence of current alcohol consumption among RTA personnel (62.6 to 66.8%) was higher than among Thai civilians (44.6%) in the NHES VI. [1] Therefore, current alcohol consumption may play an essential role in contributing to T2D in this study population. Our study suggested that alcohol consumption was a potential behavioral risk factor for T2D. Thus, reducing or stopping alcohol consumption should be encouraged to attenuate the prevalence of T2D and alleviate its complication.[29-31] According to the cultural context among RTA personnel, reduced harmful use of alcohol may be a priority.[32] Therefore, a pattern of alcohol consumption should be assessed in annual physical health examinations. Then brief interventions such as Negotiated Interviews to encourage clients to change their risky behaviors should be contributed.[33]

In line with existing literature [34, 35], obesity is a well-known risk for T2D. Our findings demonstrated that T2D was associated with higher BMI, especially among the RTA personnel with a BMI greater than or equal to 5 kg/m^2, consistent with related studies in the US[36], China[37, 38] and India.[39] Additionally, a recent study in Thailand reported a rising trend in obesity prevalence among RTA personnel from 2017 to 2021, especially those aged less than 50 years.[4] Thus, our study suggested that weight management through lifestyle change, including a healthy diet and physical exercise, should be encouraged for RTA personnel. [40-42]

We observed that the prevalence of T2D among RTA personnel reporting regular exercise was significantly lower than that among those with sedentary behavior. This finding was comparable with the Da Qing IGT and Diabetes Study, indicating that exercise intervention significantly reduced the incidence of diabetes over six years among those with IGT.[42] Therefore, our study suggested that regular exercise and progressive resistance training should be encouraged in this population.[42, 43] Vigorous exercise rarely causes heat injuries and cardiovascular events,[44,45] and physical exercise should be performed appropriately based on related guidelines. [46]

Compared with RTA personnel without HT comorbidity, we found that those with existing HT had a higher T2D prevalence. This observation was likely due to the well-documented positive relationship between HT and T2D.[38, 47, 48] T2D and HT are closely interlinked because of shared mechanisms and risk factors, for example, inappropriate activation of the renin-angiotensin-aldosterone system, endothelial dysfunction, vascular inflammation, arterial remodeling and obesity.[3, 34] Thus, effective programs should target individuals with HT, including nonpharmacologic treatment [49, 50] and appropriate pharmacologic therapy. [3, 51, 52]

This study provided valuable insights into the prevalence of T2D and its associated factors in Thailand, representing a large sample size of RTA personnel. These data help produce strategies for the primary prevention of T2D and its complications, such as ASCVD, in this population. However, further study on longitudinal analysis to explore the long term effect and time-varying risk factors for type 2 diabetes is needed.

This study encountered several limitations. First, the study was a serial cross-sectional study; therefore, the results could present only an association between T2D and its associated factors. Second, approximately 90% of study participants were male RTA personnel; however, the results demonstrated the actual situation in this study population. Third, information on lifestyle factors was collected using the questionnaires. Therefore, the recall bias could have occurred. Fourth, some variables were collected very broadly, for example, the intensity and frequency of alcohol consumption. In addition, the present study did not collect the intensity and frequency of tobacco use. Similarly, we needed more detailed data on the intensity, frequency or type of exercise. Fourth, we used the collected data health examination database; thus, data on some behavioral factors needed to be included, such as smoking status (2.1%), alcohol consumption (1.7%) and regular exercise (2.0%). However, this study comprised a large sample size, so the existing data would be included in the analysis. Thus, available data provided valuable evidence regarding

the associations between these behavioral factors and the prevalence of T2D.

Conclusion

Our study indicated that T2D is a common health issue, especially among males, higher-aged participants and RTA personnel residing in Bangkok and the northeast. Cigarette smoking, alcohol consumption and sedentary behavior played an essential role in the prevalence of T2D in this population. Furthermore, obesity and HT comorbidity were related to T2D.

Abbreviations

T2D: type 2 diabetes, HT: Hypertension, NCDs: Noncommunicable diseases, ASCVD: Atherosclerotic cardiovascular diseases, BMI: Body mass index, FPG: Fasting plasma glucose, BP: blood pressure, RTA: Royal Thai Army, RTAMED: Royal Thai Army Medical Department, NHES: National Health Examination Survey, APR: Adjusted prevalence ratio, CI: Confidence interval, SD: standard deviation

Consent for publication

This manuscript includes details and images unrelating to any individual.

Data availability

The data supporting this study's findings are available from the Royal Thai Army Medical Department, Bangkok, Thailand. Still, restrictions apply to the availability of these data, which were used under license for the current study, and are publicly available. However, data are available from the authors upon reasonable request and with permission of the Royal Thai Army Medical Department, Bangkok, Thailand (contact Boonsub Sakboonyarat via boonsub 1991@pcm.ac.th).

Competing interests

The authors declare that they have no competing interests.

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