ORIGINAL ARTICLE

Prevalence of and factors related to diabetes among aquaculture workers in Hai Phong, Vietnam: a cross-sectional study

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ABSTRACT

Diabetes is one of the non-communicable diseases that occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. The disease can lead to dangerous complications such as blindness, kidney failure, heart attacks, strokes, and limb amputation. A cross-sectional study was conducted through fasting blood sugar measurements and face-to-face interviews with 1,220 aquaculture workers to assess the prevalence and factors related to diabetes. The prevalence of diabetes in aquaculture workers was 7.1%, with pre-diabetes accounting for 21.2%. Multivariate logistic regression analysis showed the following results: male gender (OR = 1.62, 95% CI: 1.05 - 2.51), age ≥ 40 years old (OR = 2.31, 95% CI: 1.43 - 3.89), family history of diabetes (OR = 1.70, 95% CI: 1.01 - 3.09), overweight and obese (OR = 1.87, 95% CI: 1.15 - 2.94), hypertension (OR = 1.65, 95% CI: 1.04 - 2.62), dyslipidemia (OR = 1.68, 95% CI: 1.08 - 2.53), abdominal obesity (OR = 3.04, 95% CI: 1.91 – 4.72), irregular exercise (OR = 1.59, 95% CI: 1.02 - 2.48), smoking more than 20 cigarettes/day compared to non-smokers, working at night (OR = 2.07, 95% CI: 1.22 - 3.15), depressive symptoms (OR = 1.51, 95% CI: 1.17 - 2.87) were related factors. Aquaculture workers need to take appropriate actions such as raising their awareness, changing lifestyles, having regular health check-ups and regular blood sugar testing to prevent diabetes, especially the progression of pre-diabetes into diabetes.

Key words:
diabetes; pre-diabetes; aquaculture workers; factors related; Vietnam

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INTRODUCTION

According to the World Health Organization, non-communicable diseases are a leading cause of illness and death globally. Non-communicable diseases kill 41 million people each year, accounting for 74% of deaths worldwide.[1] Diabetes is a chronic, non-communicable disease characterized by high blood sugar levels and is one of the four common non-communicable diseases causing the highest disability and death in the world (after cardiovascular diseases, cancer, and chronic respiratory disease).[1,2] Diabetes is a community-based disease that greatly affects the patients' quality of life and is the leading cause of complications such as blindness, kidney failure, heart attacks, strokes, and limb amputation.[1–3] However, the prevalence of the disease and its complications can be reduced by adopting a healthy diet, exercising regularly, maintaining a normal body weight, limiting smoking, and moderate intake of alcohol.[1,4,5] Diabetes tends to increase globally; according to the International Diabetes Federation (IDF), the estimated global prevalence of diabetes was 151 million people in 2000, 285 million in 2009, 382 million in 2014, 415 million in 2015, 451 million in 2017, and is forecasted to increase to 693 million people in 2045. The estimated cost of caring for and treating diabetes patients worldwide was USD 850 billion in 2017.[2] In different age groups, the prevalence of diabetes was approximately 5% at age 35–39, 10% at age 45–49, 15% at age 55–59, and 20% at age 60–69.[6]

In a developing country like Vietnam, diabetes prevalence has also tended to increase in recent years. It was 1.2% in 1990, 2.7% in 2002, 5.4% in 2012 and 6.8% in 2021, the forecast for 2045 being 7.7%.[7–9] No data were available on the incidence of diabetes in aquaculture workers.

In the world, there are very few studies on the prevalence of diabetes in aquaculture workers. A community-based cross-sectional study conducted among workers in five aquaculture farms in Visakhapatnam, India, showed the prevalence of diabetes to be 9.6%.[10] Another study conducted by Ta-Chin Wang et al on 962 aquaculture workers in Taiwan showed that the prevalence of metabolic syndrome was 44.5%.[11]

Labor in the aquaculture sector is hard, dangerous, and highly specific; most of the laborers are freelance workers, frequently exposed to the water environment and affected by hard weather conditions; hygienic and safe working conditions are not guaranteed, with significant risks of potential illness.[10,12] Currently, health care for aquaculture workers in Vietnam has not received adequate attention and there is scant research on the health status of this group of workers, including factors related to diabetes. Therefore, we assessed the prevalence of and some factors related to diabetes among aquaculture workers in Hai Phong, Vietnam, in 2022. The results of the study have significance in preventing diabetes and increasing the longevity and seniority of aquaculture workers.

METHODS

Study participants

The sample consisted of 1220 aquaculture workers aged between 20 and 65 working in lagoons, sea cages, coastal areas, and islands in Hai Phong City, Vietnam, from January 2022 to September 2022.

Study design

This was a cross-sectional descriptive epidemiological study.

Sample size

The sample size was calculated based on the formula for estimating the sample size for a proportion: $n = Z^2_{(1-a/2)} \times p(1-p)/d^2$, in which Z = the level of

confidence (for a level of confidence of 95%, Z = 1.96); p = the prevalence of diabetes in Vietnam in 2021, 6.8%;[9] d = the margin of error (d value from 1% to 5%), we chose d = 2% = 0.02; *n* (minimum sample size) = 608 participants. The larger the sample size, the higher the reliability. To increase reliability, we multiplied the minimum sample size by 2, resulting in *n* = 1,216. Subsequently, *n* was rounded up to 1,220.

Samples were selected through stratified random sampling. The sampling locations in Hai Phong city with aquaculture were divided into three strata (island district, coastal district, and coastal urban district). Each stratum randomly selected one location: Cat Hai Island district, Tien Lang district, and Duong Kinh urban district. Each location randomly selected one commune with aquaculture. We proceeded to make a list of aquaculture workers in 3 areas. Each area randomly invited 450 aquaculture workers from the list table. Used a random number table to select 1,220 people from the list randomly. There were 130 subjects who were absent or refused to participate in the study.

Data collection

A clinical examination of the participants was conducted to measure height, weight, waist circumference, buttocks, pulse, and blood pressure. Weight was measured with the Japanese SECA scale (accuracy 0.1 kg). The participants stood in the middle of the scale, motionless, looking straight, with weight evenly distributed on both feet. The height was measured with a graduated ruler, accurate to mm, and recorded in cm. The participants removed their shoes and sandals and stood barefoot with their backs to the measuring tape. Waist and buttock circumference were measured with a non-elastic tape measure, and the results were recorded in cm. Arterial blood pressure was measured with an ALPK2 mercury column sphygmomanometer made in Japan. All participants were allowed to rest for 10 minutes before the examination and did not use stimulants (such as alcohol, beer, coffee, or cigarettes).

Direct interviews were conducted with the research subjects to elicit age, working experience, gender, education level, family history of diabetes, alcohol consumption, tobacco smoking habits, physical activity, etc. Their fasting plasma glucose, total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were quantified. Fasting venous blood was taken in the morning (at least 8 hours from meals) and was analyzed at the Biochemistry Laboratory of the Institute of Marine Medicine using the Beckman Coulter AU 480 automatic biochemical analyzer based on the electrochemical principle of luminescence.

Some definitions

Diagnosis criteria for diabetes: According to the American Diabetes Association (2021) (ADA), meeting one of the following four criteria makes one a diabetic: (1) fasting plasma glucose (FPG) ≥ 126 mg/dl (≥7.0 mmol /l), (2) 2-hour plasma glucose (PG) ≥ 200 mg/dL (11.1 mmol/L) during oral glucose tolerance test (OGTT), (3) HbA1c ≥ 6.5% (48 mmol/mol) and (4) random plasma glucose (PG) ≥ 200 mg/dL (11.1 mmol/L) in persons with symptoms of hyperglycemia or hyperglycemic crisis.[13] In our study, diabetes was diagnosed when fasting plasma glucose was ≥126 mg/dl (≥7.0 mmol/l) or HbA1c was ≥6.5% (48 mmol/mol) or an existing diagnosis of diabetes and previous diabetes treatment were present. Prediabetes was defined as HbA1c between 5.7% and 6.4% or FPG between 5.6 and 6.9 mmol/L.[13]

Hypertension was defined as systolic blood pressure ≥ 140 mmHg and/or

diastolic blood pressure ≥ 90 mmHg or being treated with antihypertensive drugs.[14]

Dyslipidemia was considered prevalent when one or more of the following parameters were met: total cholesterol > 5.2 mmol/L (200 mg/dL); triglycerides > 1.7 mmol/L (150 mg/dL), LDL-cholesterol > 2.3 mmol/L (>200 mg/dL), and HDL-cholesterol < 1.03 mmol/L (40 mmol/dL).[15]

The assessment of overweight and obesity was based on BMI (body mass index), calculated using the formula weight (kg)/height (m^2) according to WHO standards for Asian adults.[16] Underweight is defined as BMI < 18.5 kg/m^2, normal weight as BMI 18.50–22.9 kg/m^2, overweight as BMI 23.00–24.9 kg/m^2, and obesity as BMI ≥ 25 kg/m^2.

The assessment of abdominal obesity was based on waist-hip ratio (WHR). According to WHO standards applicable to the Asia-Pacific region, abdominal obesity was defined as WHR ≥ 0.90 (males), WHR ≥ 0.85 (females).[17]

The participants were interviewed about exercise status, including activities such as (walking, cycling, playing table tennis, gym, etc.) per week. Regular exercise was defined as at least 30 minutes/day and ≥ 5 days/week.[18]

Smoking habit: Nonsmoker is someone who has never smoked any tobacco. A person with a history of smoking is someone who used to smoke but currently no longer smokes (Ex-smoker). One who currently smoked at least one cigarette a day was considered to be having a smoking habit and we interviewed them about the number of cigarettes they smoke per day.

Habit of using alcoholic beverages (beer, wine): Drinking alcohol at harmful levels is represented by an average consumption of ≥60 g of alcohol/day for men and ≥40 g of alcohol/day for women; Drinking alcohol at a high risk involved an average consumption of approximately 40–59.9 g of alcohol/day in men and 20–39.9 g of alcohol/day in women. If the above two criteria were not satisfied, participants were categorized as drinking alcohol at the permissible level. The number of grams of alcohol was estimated as follows: Participants were asked about the number of times of drinking alcohol in 7 days and the number of alcohol units in each drink. The average amount of alcohol consumed in 7 days was calculated: [(number of drinks in 7 days) × (number of alcohol units in each drink)]/7. One unit of alcohol is equivalent to 10 grams of alcohol (equivalent to 285 ml of beer, 30 ml of spirits, or 120 ml of light wine).[19,20]

The assessment of depressive symptoms, anxiety, and stress of aquaculture workers was based on the DASS-21 scale (Depression-Anxiety-Stress Scale-21). The Dass -21 questionnaire has been standardized in Vietnam.[21] DASS-21 includes 21 questions about three issues related to mental health: depression (seven questions), anxiety (seven questions), and stress (seven questions). Each question is about a symptom corresponding to a mental health condition in the past week on a scale from 0 to 3 for each answer: "Not true of me at all," "Absolutely true of me," or "True most of the time." According to this questionnaire, DASS-21 score over 14, 7, and 9 was considered as having stress, anxiety, and depression symptoms respectively.[22]

Statistical analysis

The research data were processed by biomedical statistical methods based on SPSS for Windows version 22.0 software. (SPSS version 22.0, SPSS Inc., Chicago, IL, USA). Categorical variables were represented using frequencies and percentages (%), while continuous variables were summarized with mean and standard deviation (SD). Multivariate logistic regression analyses were employed to compute odds ratios (ORs) along with their corresponding 95% confidence intervals (CIs) to explore the associations

between diabetes risk factors among aquaculture workers. Statistical significance was determined at $p < 0.05$. Identification of risk factors was carried out through multivariate logistic regression analysis, employing a binary dependent variable denoting diabetes status. The variables included in the model as potential risk factors comprised gender, age group, education level, family history of diabetes, BMI, hypertension, dyslipidemia, abdominal obesity, regular exercise, number of cigarettes smoked, drinking alcohol, working at night and symptoms of stress, anxiety, and depression.

Ethical approval

This study was approved by the Ethics Committee in Biomedical Research of the Institute of Marine Medicine, according to decision 09/2022/QD-YHB, dated January 5, 2022. Participation in the study by all the aquaculture workers was completely voluntary and they signed the consent form paper to participate in the study. Participants were examined for free and received support in the form of Vietnam Dong 100,000.

RESULTS

Through the study involving 1,220 aquaculture workers in lagoons, sea cages, and coastal areas and islands of Hai Phong City to determine the prevalence of diabetes and factors related to it, we obtained the following results:

Table 1. Some characteristics of study participants (n=1220)

Characteristic		No. (%)
Gender	Male	537 (44.0)
	Female	683 (56.0)
Age (years)	mean (SD); min - max	41.8 ± 11.7; 20 - 65
	< 40	526 (43.1)
	≥ 40	694 (56.9)
Working experience (years)	mean (SD); min - max	16.3 ± 8.9; 2 - 41
	<10	328 (26.9)
	10-19	488 (40.0)
	20-29	267 (21.9)
	≥30	137 (11.2)
Education level	High school and above	351 (28.8)
	Secondary school	668 (54.7)
	Elementary school and under	201 (16.5)
Work at night	Yes	767 (62.9)
	No	453 (37.1)
Hypertension	Yes	304 (24.9)
	No	916 (75.1)
BMI (body mass index)	Underweight	61 (5.0)
	Normal weight	742 (60.8)
	Overweight	281 (23.0)
	Obesity	136 (11.2)
Abdominal obesity	Yes	506 (41.5)
	No	714 (58.5)

Note: SD = standard deviation; No. = number

The aquaculture workers were mostly female (56.0%), with males comprising a minority (44.0%) (Table 1). The average age was 41.8 years ± 11.7 years; the lowest age was 20 and the highest was 65, with < 40 years at 43.1% and ≥ 60 years at 56.9%. The average working experience was 16.3 ± 8.9 years, the lowest being 2 years, and the highest being 41 years, with <10 years at 26.9%, 10–19 years at 40.4%, 20–29 years at 21.9%, and ≥30 years at 11.2%. The education level of aquaculture workers was quite low, the majority having completed secondary school (54.7%), with high school and above at 28.8%, elementary education and lower at 16.5%. Workers who regularly work at night was 62.9%. The prevalence of hypertension among aquaculture workers was 24.9%, with overweight at 23.0%, obesity at 11.1%, and abdominal obesity at 41.5%.

The prevalence of diabetes and pre-diabetes among aquaculture workers was 87/1220 (7.1%) and 258/1220 (21.2%), respectively (Figure 1).

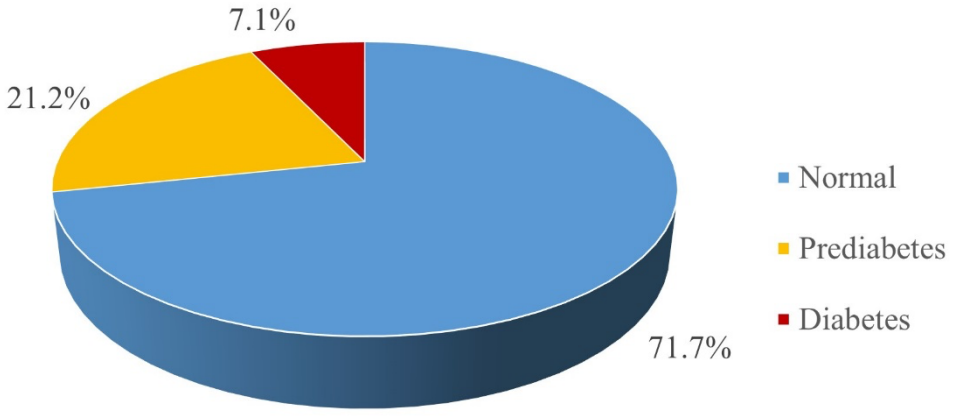

Figure 1. Prevalence of diabetes and prediabetes in aquaculture workers (n=1220)

The multivariate analysis of factors related to diabetes in aquaculture workers, research results (Table 2) revealed the identified factors, which included: male gender (OR = 1.62, 95% CI: 1.05 - 2.51, $p < 0,05$), age ≥ 40 years old (OR = 2.31, 95% CI: 1.43 - 3.89, $p < 0,01$), family history of diabetes (OR = 1.70, 95% CI: 1.01 - 3.09, $p < 0,05$), overweight and obese (OR = 1.87, 95% CI: 1.15 - 2.94, $p < 0,05$), with hypertension (OR = 1.65, 95% CI: 1.04 - 2.62, $p < 0,05$), with dyslipidemia (OR = 1.68, 95% CI: 1.08 - 2.53, $p < 0,05$), abdominal obesity (OR = 3.04, 95% CI: 1.91 – 4.72, $p < 0,01$), irregular exercise (OR = 1.59, 95% CI: 1.02 - 2.48, $p < 0,05$), non-smokers led to a 0.53 times lower risk of diabetes than those who smoke over 20 cigarettes/day, aquaculture workers who work at night (OR = 2.07, 95% CI: 1.22 - 3.15, $p < 0,05$), aquaculture workers with depressive symptoms (OR = 1.51, 95% CI: 1.17 - 2.87, $p < 0,05$).

DISCUSSION

Currently, Vietnam is facing a dual disease model, which includes both infectious and non-communicable diseases. Of these, non-communicable diseases account for approximately 70% of the disease burden and are the leading cause of death (accounting for 77% of total deaths).[23] Among non-communicable diseases, diabetes is the leading cause of death, disability, and medical burden.[24] A cross-sectional study was conducted by measuring fasting plasma glucose in 1,220 aquaculture workers aged between 20 and

65 and found the rates of diabetes and pre-diabetes among them as 7.1% and 21.2%, respectively (Figure 1). Our study showed higher figures than some other studies on different subjects in Vietnam.[8,9,25] According to a study on the prevalence of diabetes and hypertension in Vietnam based on data analysis from PubMed, EMBASE, CINHAL, and Google Scholar during the period January 1, 2000, to September 30, 2020, the prevalence of diabetes and hypertension in Vietnam is 6.0% and 25.0%, respectively.[25] Another study on adults aged 20–70 in Khanh Hoa province, Vietnam, in 2014 indicated the rate of diabetes to be 7.2%.[26] The prevalence of diabetes and pre-diabetes in people aged 30–65 in Northern Vietnam was 6.0% and 13.5%, respectively.[27] We believe that it can be explained by the facts that aquaculture workers in Vietnam are mostly freelance workers, have an unhealthy diet and lifestyle with sedentary habits, and are often stressed due to sick seafood and product consumption,[28] which are risk factors for non-communicable diseases, including diabetes.

The rate of prediabetes among aquaculture workers is very high (21.2%). Pre-diabetes can progress to diabetes or not depending on a scientific diet, exercise, good and blood sugar control. However, if there is no plan to adjust diet and lifestyle, 37% of people with prediabetes will develop type 2 diabetes after 4 years. If a person changes their lifestyle, the time it takes for a person with prediabetes to develop into diabetes is 10 years. Even practicing a healthy diet and having regular health check-ups can reverse the progression of prediabetes.[29]

The percentage of aquaculture workers with diabetes in our study was lower than that in the study by Yalamanchi et al. on aquaculture workers in India (9.6%).[10] The author's research shows that aquaculture workers in India are exposed to risk factors for non-communicable diseases, including diabetes: 51.1% were alcoholics, 50.4% had a sedentary lifestyle, 65.2% had central obesity, and 28.2% had hypertension.[10]

The prevalence of diabetes varies between countries depending on geographical area, economic development, income, nutritional status, culture, etc.[30] In Cameroon, it ranged from 5.8% to 7.1%;[31] in rural areas of China, it was 4.2%;[32] in the US, it was 12.1%;[33] in Malaysia, it ranged from 11.6% to 15.2%;[34] in Norway, it was 9.9%;[35] and in Japan, it was 8.0% in males and 3.3% in females.[36]

Table 2. Multivariate analysis of factors related to diabetes among aquaculture workers

Variable	n	With diabetes n (%)	Without diabetes n (%)	Multivariate AOR (95%CI)
Gender:				
Male	537	49 (9.1)	488 (90.9)	1
Female	683	38 (5.6)	645 (94.4)	**1.62* (1.05 - 2.51)**
Age group (years):				
≥ 40 years old	694	63 (9.1)	631 (90.9)	1
< 40 years old	526	24 (4.6)	502 (95.4)	**2.31** (1.43 - 3.89)**
Education level:				
High school and above	351	24 (6.8)	327 (93.2)	1
Secondary school	668	49 (7.3)	619 (92.7)	0.91 (0.54 - 1.56)
Elementary school and under	201	14 (7.0)	187 (93.0)	0.97 (0.49 - 1.98)

Variable	n	With diabetes n (%)	Without diabetes n (%)	Multivariate AOR (95%CI)
Family history of diabetes:				
Yes	104	13 (12.5)	91 (87.5)	1
No	1116	74 (6.6)	1042 (93.4)	**1.70* (1.01 - 3.09)**
BMI (body mass index):				
≥ 23	417	45 (10.8)	372 (89.2)	1
<23	803	42 (5.2)	761 (94.8)	**1.87* (1.15 - 2.94)**
Hypertension:				
Yes	304	32 (10.5)	272 (89.5)	1
No	916	55 (6.0)	861 (94.0)	**1.65* (1.04 - 2.62)**
Dyslipidemia:				
Yes	327	34 (10.4)	293 (89.6)	1
No	893	53 (5.9)	840 (94.1)	**1.68* (1.08 - 2.53)**
Abdominal obesity:				
Yes	506	59 (11.7)	447 (88.3)	1
No	714	28 (3.9)	686 (96.1)	**3.04** (1.91 – 4.72)**
Regular exercise:				
No	422	40 (9.5)	382 (90.5)	1
Yes	798	47 (5.9)	751 (94.1)	**1.59* (1.02 - 2.48)**
Number of cigarettes smoked:				
Non-smoker	506	27 (5.3)	479 (94.7)	1
Ex-smoker	217	15 (6.9)	202 (93.1)	0.77 (0.42 - 1.56)
<10 cigarettes/day	256	19 (7.4)	237 (92.6)	0.71 (0.38 - 1.34)
10-20 cigarettes/day	169	16 (9.5)	153 (90.5)	0.62 (0.35 - 1.27)
>20 cigarettes/day	72	10 (13.9)	62 (86.1)	**0.47* (0.26 - 0.92)**
Drinking alcohol:				
No alcohol	704	48 (6.8)	656 (93.2)	1
Drinking alcohol at the permissible	124	4 (3.2)	120 (96.8)	**1.67* (1.02 - 3.77)**
Drinking alcohol at a high risk	234	18 (7.7)	216 (92.3)	0.88 (0.51 - 1.48)
Drinking alcohol at harmful	158	17 (10.8)	141 (89.2)	0.65 (0.41 - 1.09)
Work at night				
Yes	767	68 (8.9)	699 (91.1)	1
No	453	19 (4.2)	434 (95.8)	**2.07* (1.22 - 3.15)**
Stress symptoms:				
Yes	131	11 (8.4)	120 (91.6)	1
No	1089	76 (7.0)	1013 (93.)	1.19 (0.67 - 2.18)
Anxiety symptoms:				
Yes	199	20 (10.1)	179 (89.9)	1
No	1021	67 (6.6)	954 (93.4)	1.46 (0.93 - 2.61)
Depression symptoms:				
Yes	350	34 (9.7)	316 (90.3)	1
No	870	53 (6.1)	817 (93.9)	**1.51* (1.17 - 2.87)**

Abbreviation: AOR = Adjusted odds ratio, CI: Confidence Interval
Notes: Bolded numbers are significant at $p<0.05$ (*<0.05, **<0.01)

The results of the multivariate analysis of factors related to diabetes among aquaculture workers (Table 2) revealed that males were more likely to have diabetes than females. This result was similar to some previous findings.[25,32,37,38] Ages of 40 and more carried a higher risk of diabetes than those under 40. Van Dat Nguyen and colleagues reported the prevalence of diabetes and pre-diabetes in people over 45 years old to be 8.1% and 51.1%, respectively.[39] Another study in Da Nang indicated that in Vietnamese people aged 45 to 69, the rates of diabetes and pre-diabetes were 11.4% and 52.9%, respectively. Thus, advanced age was a risk factor for diabetes. A family history of diabetes increased the risk of diabetes compared to no family history of diabetes. The results of this study were similar to some previous reports indicating that a family history of diabetes increases the risk of diabetes.[32,39]

Overweight, obesity and abdominal obesity carried a higher risk of diabetes. It may be attributed to the fact that overweight, obesity, and abdominal obesity are closely related to insulin resistance, leading to a lack of insulin due to a reduced number of receptors in peripheral tissues. Overweight, obesity, and abdominal obesity have been shown to increase the risk of diabetes.[32,36,37,40]. Hypertension is a risk factor for diabetes. Conversely, diabetes also increases the risk of high blood pressure. The study results were consistent with those of other authors.[31,32] Dyslipidemia workers had a higher risk of diabetes than those without dyslipidemia. Research by Uehara and colleagues on Japanese workers showed a close association between dyslipidemia and diabetes.[36] Another study in China also showed that dyslipidemia increases the risk of diabetes.[37]

Some of our results (Table 2) showed that irregular exercise led to a higher risk of diabetes than regular exercise. This observation is consistent with some previous studies.[32,36] Thus, regular exercise had the effect of reducing plasma glucose levels in diabetic patients while helping to maintain the stability of blood lipids and blood pressure and improving insulin resistance and mental health, thereby reducing the risk of developing diabetes.[41] A study in China also showed that regular exercise reduces the risk of type 2 diabetes (*OR* = 0.86; 95% *CI*: 0.76–0.98).[4]

Aquaculture workers who smoke more than 20 cigarettes/day were more likely to develop diabetes than non-smokers. Research by Shi et al. showed that cigarette smoking was associated with an increased risk of type 2 diabetes; *OR* = 1.25 (95% *CI*: 1.00–.56) for smoking more than 20 cigarettes per day and *OR* =1.28 (95% *CI*: 1.04–1.57) for smoking more than 40 packs/year.[4] Another study in Japan also showed that smoking more than 20 cigarettes/day increases the risk of type 2 diabetes.[36] Drinking alcohol at the permissible level reduced the risk of diabetes compared to not drinking alcohol. Shi et al.'s study on 51,464 Chinese men showed that moderate alcohol consumption (1–3 drinks/day) was inversely associated with the risk of type 2 diabetes (*OR* = 0.80; 95% *CI*: 0.67–0.94).[4]

Aquaculture workers who often work at night have a higher risk of diabetes. During the research process, we found that these workers engage in nocturnal activities such as tending to and feeding marine livestock, which can be a risk factor for sleep disorders. On the other hand, shorter sleep duration and erratic sleep behavior have been associated with higher rates of obesity, metabolic syndrome, and diabetes.[42] Workers with depressive symptoms were more likely to have diabetes than those without such symptoms. These results were consistent with those of

some other authors.[43–45] To explain this, we believe that the occurrence of depressive symptoms activates the hypothalamic-pituitary-adrenal axis, resulting in inflammation; further, sleep disorders, sedentary lifestyles, unhealthy eating habits, and environmental and cultural risk factors also increase the risk of diabetes.[44] Thus, depression increases the risk of diabetes, and conversely, having diabetes increases the risk of symptoms of depression.

Strengths and limitations of the research: Until now, no research has been carried out on the health status, including diabetes, of aquaculture workers in Vietnam. The results of this study help detect diabetes and pre-diabetes early, thereby providing appropriate prevention and treatment solutions. The research has not fully analyzed some of the risk factors for diabetes, such as diet, nutrition, and the effects of working conditions.

CONCLUSIONS

Diabetes and pre-diabetes are a public health problem affecting aquaculture workers, with a prevalence of 7.1% and 21.2%; that is, 1 in 14 people has diabetes. Being male, having an age of 40 or more, having a family history of diabetes, obesity, abdominal obesity, hypertension, dyslipidemia, irregular exercise, smoking more than 20 cigarettes per day, working at night and having symptoms of depression have been identified as factors related to diabetes. Aquaculture workers need to take appropriate actions such as raising their awareness, changing lifestyles, have regular health check-ups and regular blood sugar testing to prevent diabetes, especially the progression of pre-diabetes into diabetes.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHORS' CONTRIBUTIONS

CTTQ conceived the research idea and conducted the entire study, including data collection, experimentation and analysis. TNV took responsibility for conception and design, writing the manuscript, revision, and finalization. DNHV took charge of data analysis and interpreting the findings. PDT Collection and assembly of data; administrative, technical or logistic support.

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