



The effect of occupational factors on the incidence of prediabetes: Results from the PERSIAN Guilan Cohort Study

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ABSTRACT

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Background: Evidence indicates that diabetes is typically preceded by a period of prediabetes. Although less widely recognized, accumulating research suggests that stress, along with other occupational and lifestyle factors, may be directly associated with the development of prediabetes. Therefore, this study aimed to investigate the effect of occupational factors on the incidence of prediabetes using data from the Prospective Epidemiological Research Studies of the Iranian Adults (PERSIAN) Guilan Cohort Study (PGCS).

Method: This study was conducted as part of the PGCS. A total of 477 employed men aged 35–70 years with prediabetes were included as the case group. In addition, 497 age-matched employed men without prediabetes were enrolled as the control group. Data were collected using a demographic questionnaire and the Job Content Questionnaire (JCQ).

Results: Our results indicated that the majority of participants with prediabetes had fewer than 12 years of education (44.9%), and educational level differed significantly between the two groups ($P \leq 0.05$). Analysis of job content dimensions revealed significant differences between the prediabetes and control groups across all factors except for job demands ($P = 0.301$) and psychological job demands ($P = 0.154$). For all other dimensions, differences between the two groups were statistically significant ($P \leq 0.001$). Based on the study results, most participants were classified as experiencing isostrain, indicating high levels of occupational stress.

Conclusion: These findings highlight the importance of examining job content and occupational factors to reduce the risk of non-communicable diseases, including prediabetes.

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1. Introduction

Non-communicable diseases (NCDs) are responsible for a significant proportion of deaths and injuries worldwide. According to the results of the global study of the burden of diseases in 2015, over 39 million deaths have occurred due to NCDs, which is 71.3% of the world's total deaths [1]. Diabetes mellitus is the most prevalent metabolic disorder worldwide and has been described by the World Health Organization as a "latent epidemic." As one of the most costly chronic diseases, diabetes is a leading cause of blindness among individuals aged 20–70 years in many countries and is also a major contributor to lower-limb amputation and chronic kidney failure [2].

Evidence from studies conducted in the Eastern Mediterranean Region (EMRO) indicates that the prevalence of prediabetes is approximately 12.2%; similarly, the estimated prevalence in Iran is 12.8% [3]. Studies indicate that diabetes is typically preceded by a period of prediabetes. According to clinical definitions, prediabetes is characterized by blood glucose levels that are higher than normal but do not yet meet the diagnostic criteria for diabetes [4]. During this stage, the body must produce increased amounts of insulin to maintain glucose homeostasis. Prediabetes is defined by a fasting plasma glucose level of 100–125 mg/dL or a 2-hour plasma glucose level of 140–199 mg/dL following a 75-g oral glucose tolerance test [5].

Prediabetes, even in the absence of progression to overt diabetes, is associated with an increased risk of complications such as cardiovascular damage [6]. Clinical evidence indicates that diabetes-related complications may develop prior to the formal clinical diagnosis of the disease. Consequently, early identification of dysglycemia, evaluation of the prediabetic stage, and recognition of factors influencing the development of diabetes are of critical importance [7]. The prevalence of prediabetes in adults aged 20 years and older in the United States was estimated to be 35% [8].

Numerous factors such as socio-cultural factors, genetic and positive family history are risk factors for the development of prediabetes and diabetes. Evidence has also shown that occupational factors such as stress executive functions can play a role in prediabetes and diabetes [9,10].

Acute or chronic stress responses are associated with increased circulating blood glucose, decreased insulin sensitivity, chronic inflammation, and abnormal fat metabolism, changes that often occur with diabetes [11, 12]. Also, inappropriate job content may also result in situations where workers experience a mismatch between their skills and abilities and job demands or pressures, leading to occupational stress and, ultimately, to adverse physical and mental health outcomes [13]. In Iran, the prevalence of diabetes has doubled over the past three decades. National studies estimated that the prevalence of diabetes in 2013 was 13.8% [14] and

according to the International Diabetes Federation, approximately 7.7% of the general population of Iran has prediabetes [15]. Evidence also suggests that workers exposed to job-related stress have a higher risk of developing metabolic disorders due to the physiological effects of occupational stress [16-20]. Although less widely recognized, research indicates that stress, in combination with other factors, may be directly associated with the development of prediabetes [21].

Given the high prevalence of prediabetes in Iran and the limited number of studies examining the relationship between occupational factors and prediabetes, the present study aimed to investigate the effect of occupational factors on the incidence of prediabetes using data from the Prospective Epidemiological Research Studies of the Iranian Adults (PERSIAN) Guilan Cohort Study (PGCS).

2. Materials and Methods

2.1 Study design and population

This cross-sectional study is part of PGCS, conducted at the Gastrointestinal and Liver Diseases Research Center in Rasht, Iran. The profile and methodology of the Guilan Cohort have been described in detail previously [22,23].

Written informed consent was obtained from all participants prior to enrollment. The inclusion criteria were: male participants aged 35–70 years; willingness to participate; current employment and residence in urban or rural areas of Some'e Sara. Exclusion criteria included unemployment, diagnosed diabetes, and prediabetic individuals who were unemployed. Prediabetes was defined using the following criteria: fasting plasma glucose between 100–125 mg/dL, no prior history of diabetes, and no use of antidiabetic medications.

Diabetes was defined as a fasting plasma glucose ≥ 126 mg/dL, a prior diagnosis of diabetes, or the use of antidiabetic medications [24]. For each participant, trained technicians collected 25 mL of fasting blood, labeled the samples, and transported them in a cold box to the cohort center laboratory [25]. To establish the control group, 497 age-matched employed men without prediabetes were also recruited.

2.2 Data collection

Data were collected using two questionnaires the demographic questionnaire and the Job Content Questionnaire (JCQ) [26], in addition to information obtained from the cohort database. The demographic questionnaire included items on age; anthropometric measurements, including body mass index (BMI), waist circumference, and hip circumference; educational level; marital status; work shift type; and job type in terms of physical activity.

Laboratory and metabolic parameters extracted from cohort records included metabolic equivalent of task (MET), triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL).

The JCQ is a widely used instrument for assessing the social and psychosocial dimensions of the work environment. This questionnaire evaluates key job characteristics, including decision latitude, psychological job demands, and social support. Responses are recorded on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The JCQ consists of 27 items covering the following dimensions: skill discretion (6 items), decision-making authority (3 items), psychological job demands (5 items), coworker support (4 items), supervisor support (4 items), psychological job demands (5 items), and job insecurity (3 items). The social support dimension was calculated by summing the scores for coworker support and supervisor support [27]. Decision latitude was derived from the combined scores of skill discretion and decision-making authority.

2.3 Statistical analysis

Continuous variables are presented as mean \pm standard deviation (SD), and categorical variables are expressed as frequencies and percentages. Parametric statistical methods were used for data analysis, including the chi-square test for categorical variables and the independent t-test for continuous variables. The z-test was applied to compare global scores. A P value < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS software, version 16.0.

3. Results

In this study, a total of 477 employed men with prediabetes and 497 healthy employed men were included in the analysis. The demographic characteristics of the two study groups are presented in Table 1.

Among participants with prediabetes, the majority were older than 50 years (52.2%), had fewer than 12

years of formal education (91.6%), had a body mass index (BMI) greater than 25 kg/m² (65.7%), and were engaged in rotating shift work (70.1%). As shown in Table 1, educational level differed significantly between the two groups ($P \leq 0.001$), with a higher proportion of participants with more than 12 years of education observed in the control group. No statistically significant differences were found between the two groups with respect to age, BMI, hip circumference, waist circumference, or shift work status ($P > 0.05$).

The results of clinical and metabolic parameters extracted from cohort data are summarized in Table 2. Compared with the control group, participants with prediabetes had significantly lower levels of physical activity, as measured by MET ($P = 0.012$), and significantly higher levels of TG ($P = 0.003$) as well as lower levels of HDL ($P = 0.002$). LDL levels did not differ significantly between the two groups ($P = 0.155$). In addition to demographic characteristics, working conditions, including fixed and moving working hours, were also examined.

The mean (SD) sitting time per week among participants with prediabetes was 28.12 (20.04) hours, representing the highest proportion of working time compared with other work-related activities. Statistical analysis revealed a significant difference between the two groups in both sitting and walking working hours ($P \leq 0.001$), as illustrated in Figure 1.

Analysis of the association between job content dimensions and the incidence of prediabetes demonstrated that, with the exception of job demands ($P = 0.301$) and psychological job demands ($P = 0.154$), significant differences were observed between the two study groups across all job content factors ($P \leq 0.001$). For all dimensions showing statistically significant differences, mean job content scores were higher in the control group than in the prediabetes group (Table 3). Comparison of job content questionnaire scores with national mean values using Z-scores revealed statistically significant differences across all job content dimensions in both study groups ($P \leq 0.001$). All dimensions of the questionnaire were reported at levels lower than the corresponding national mean scores, as illustrated in Figure 2.

Table 1. Categorical demographic and occupational variables were compared between the prediabetes and control groups.

Variables	*Prediabetes (N= 477)		Control (N= 497)		**P value	
	Number	Percent	Number	Percent		
Age (year)	<50	228	47.80	252	50.70	0.405
	>50	249	52.20	245	49.30	
Education (year)	<12	437	91.60	409	82.30	≤ 0.001
	>12	40	8.40	88	17.70	
BMI (kg/m ²)	<25	164	34.30	191	38.40	0.204
	>25	313	65.70	306	61.60	
Hip circumference (cm)	<100	248	52.00	265	53.30	0.700
	>100	229	48.00	232	46.70	
Waist circumference (cm)	<94	228	47.80	264	53.10	0.109
	>94	249	52.20	233	46.90	
Shift working	Fixed	143	29.90	149	30.00	0.112
	Rotating	334	70.10	348	70.00	

* FBS: 100-125 mg/dl; **P-values were calculated based on chi-square test; Statistical significance was set at $p < 0.05$.

Table 2. Comparison of Clinical and Metabolic Parameters Between the Prediabetes and Control Groups.

Variable		*Prediabetes (N= 477)		Control (N= 497)		**P value
		Number	Percentage	Number	Percentage	
MET (kcal/kg/hour)	< 50	208	43.60	257	51.70	0.012
	> 50	269	56.40	240	48.30	
TG (mg/dL)	< 150	220	46.10	277	55.70	0.003
	> 150	257	53.90	220	44.30	
HDL (mg/dL)	< 46	254	53.20	313	63.00	0.002
	> 46	223	46.80	184	37.00	
LDL (mg/dL)	< 100	172	36.00	157	31.50	0.155
	> 100	305	64.00	340	68.50	

MET: Metabolic equivalent of task; TG: Triglycerides; HDL: High-density lipoprotein; LDL: Low-density lipoprotein; * FBS: 100-125 mg/dl; **P values were calculated based on chi-square test; Statistical significance was set at p < 0.05.

Table 3. Mean scores of Job Content Questionnaire dimensions were compared between the prediabetes and control groups.

Job Content Questionnaire Dimensions	Prediabetes* (N= 477)		Control (N= 497)		**P value
	Mean	SD	Mean	SD	
Job decision-making authority	56.18	10.72	63.36	10.80	≤ 0.001
Job skill discretion	29.11	5.61	31.56	5.78	≤ 0.001
Decision latitude	27.02	6.09	31.79	6.65	≤ 0.001
Job demands	36.82	3.79	37.07	3.81	0.301
Social support	17.70	2.19	19.34	2.67	≤ 0.001
Coworker support	8.34	1.90	9.20	3.38	≤ 0.001
Supervisor support	9.36	2.49	10.14	3.25	≤ 0.001
Job insecurity	5.28	1.13	5.92	1.15	≤ 0.001
Psychological job demand	26.90	6.78	27.30	6.34	0.154

SD: Standard deviation; * FBS: 100-125 mg/dl; **P values were calculated based on independent t-test; Statistical significance was set at p < 0.05.

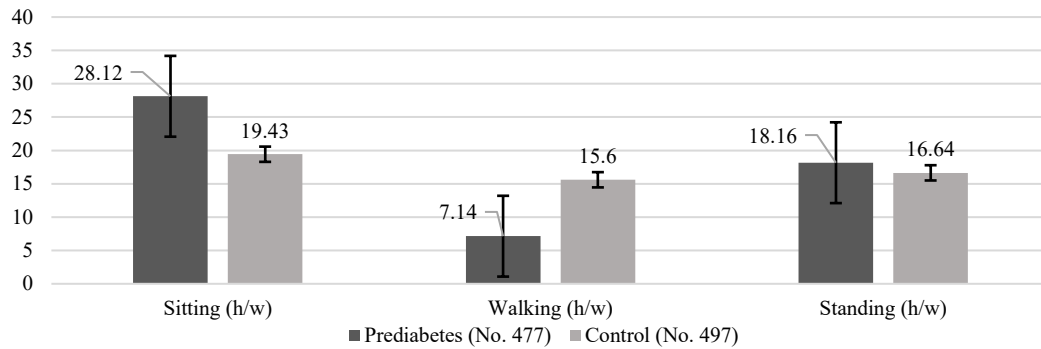


Figure 1. Mean and standard deviation of different working conditions in terms of hours per week in the two groups.

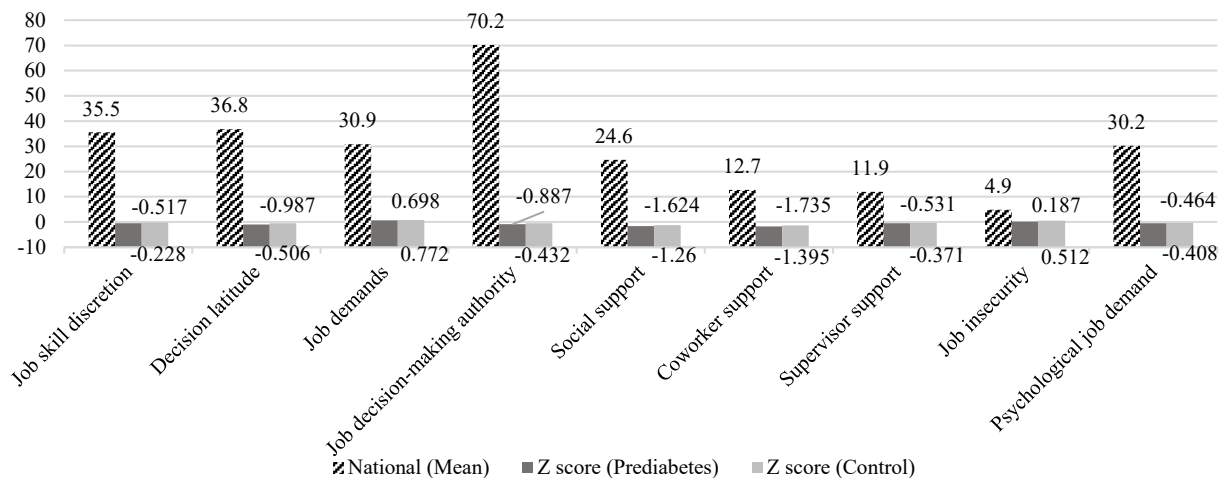


Figure 2. The difference between the national mean value for job content and Z score between the two groups (Z score of the control group is below the graph).

4. Discussion

The aim of this study was to investigate the relationship between occupational factors and the incidence of prediabetes among individuals whose information was recorded in Guilan Cohort Study. The results of the present study showed that all dimensions of the job content questionnaire except job demand and psychological job demands in the two groups were significantly different ($P \leq 0.001$). In addition, there was a significant relationship between the national mean score of job content and Z score in the two groups in all dimensions of job content ($P \leq 0.001$). The increase in the number of new cases of people with type 2 diabetes, along with its complications, has become a major public health concern in industrialized and developing countries [28-32]. It seems that the most effective way to manage this concern is to prevent diabetes and its complications. Genetic predisposition, environmental and lifestyle factors such as general obesity, abdominal obesity, unhealthy diet and lack of physical activity are risk factors for type 2 diabetes [33-35].

With the spread of globalization and greater cross-national mobility and changing employment relationships, stress has become significantly more important in occupational health and is considered as one of the leading causes of economic loss around the world. There is also evidence that stress can affect individual health and important organizational outcomes such as productivity [36]. The results of studies show that inappropriate work environment conditions such as high job demands, low level of job control and low social support increase job stress and consequently negative consequences [37]. Given that no study has been done on the dimensions of job content and its relationship in prediabetic people, it is believed that our study results can provide the necessary basis for evaluating the dimensions of job content and their effect on health. The results of this study showed that most participants with prediabetes were over 50 years old, had an education of less than 12 years, and a BMI of more than 25.

Also, our results showed that most people with prediabetes were over 50 years old, educated less than 12 years, and BMI more than 25, which was statistically significant between the level of education, TG, and HDL between the two studied groups. Similar studies have shown that aging, high BMI are among the risk factors for diabetes [38]. Studies have also confirmed the supportive role of education in diabetes, so that with increasing levels of education, the prevalence of diabetes will decrease, which may be due to maintaining a healthy lifestyle [39,40]. In the present study, participants with an education level of less than 12 years were more likely to have prediabetes, which is consistent with the studies mentioned. Studies have also shown an association between the high prevalence of hypertension and dyslipidemia with diabetes [28,41], which confirms the findings of the present study on the

association between TG, HDL and prediabetes.

The results of shift working also showed that participants with rotating shift in both groups are more than participants with fixed shift, but no significant relationship was found between the two groups, which can be due to the small number of participants working in rotating shift. In a study by Penn et al. in the United States, which investigated the relationship between rotating shift work and risk of type 2 diabetes, results showed that there was an association between rotating night shifts and risk of developing diabetes [42]. In a 2003-2009 study, Ika et al. also studied the effects of long hours and shift working on diabetes among Japanese workers. People who worked shifts and worked more than 45 years a week had a significant increase in their incidence of diabetes [43].

In addition, the way of doing work while sitting, standing and walking was also examined. The results showed that there was a significant difference between the two groups in sitting and walking. Evidence shows that despite national education efforts to reduce inactivity, 24% of American adults do not participate in leisure activities [44]. There is an inverse relationship between moderate physical activity and type 2 diabetes in cross-sectional studies [45,46]. In this regard, prospective studies have shown that moderate to severe physical activity can prevent type 2 diabetes [47]. Overall, there is evidence for the effective role of physical activity in preventing type 2 diabetes. This evidence is also somewhat obvious in the present study, so that people who were more sedentary and had less walking hours per week were more likely to develop prediabetes.

Other results of the present study include a significant difference between the dimensions of job content and the incidence of prediabetes. According to the results, the situation of prediabetic participants is at a low level in terms of freedom of decision or control, which increases the level of job stress. The mean score for job decision-making authority in the prediabetic group was significantly lower than its value in the control group; thus, it can be said that job decision-making authority affects a person's general health. This means that these people with the disorder have less control over various skills and aspects of job performance. Working in such conditions increases the likelihood of psychological harm [48]. Also, the mean score for the decision latitude scale in the prediabetic group was significantly lower than its value in the control group; thus, it can be said that the decision latitude scale affects the general health of the individual. This finding is consistent with the results of a previous study [49].

Over the past decade, the role of psychosocial occupational factors on employee health has received more attention [49]. Factors such as job demands, job nature, decision-making authority, social interaction are in the field of psychosocial occupational factors. Some examples that increase individual control over their job are: Decision-making authority as one of the

psychosocial occupational factors which allows employees to plan their work according to organizational policies and production needs; consultation in decisions that affect their work which allows employees to choose the best work process and work order and increase their participation in the production process [50]. Studies have shown that social support reduces job stress, increases job satisfaction and prevents insomnia and is associated with reduced depression and anxiety. Also, social support acts as a protective barrier against workplace stressors. There is evidence in a large number of studies that low levels of social support increase the risk of mental disorders [51].

In this study, people with prediabetes were at a higher level than healthy people in terms of job insecurity and this difference was reported to be statistically significant. It can be concluded that in this study, job insecurity can be considered as a factor affecting prediabetes. This study has several limitations that should be considered when interpreting the results. One major limitation is the exclusion of women, as most female participants in the cohort were housewives and not employed in jobs with an employer, which limits the generalizability of the findings to the female working population. Additionally, the cross-sectional nature of the study prevents establishing causal relationships between occupational factors and prediabetes. Future research is recommended to include employed women to examine gender-specific occupational influences on prediabetes. Longitudinal studies are also suggested to assess the impact of occupational stress and job content dimensions on the development and management of diabetes over time. Moreover, comparing self-employed individuals with employees under an employer could provide further insights into the role of employment type in prediabetes risk. Addressing these limitations in future studies would help clarify the complex interactions between occupational factors and metabolic health.

This study demonstrates that a substantial proportion of participants were exposed to isostrain conditions characterized by high job demands, low job control, and limited social support reflecting elevated occupational stress. High job stress, low social support, and prolonged working hours were significantly associated with an increased incidence of prediabetes. Additionally, lower levels of workplace physical activity were linked to prediabetes, highlighting the protective role of occupational physical activity. These findings underscore the importance of reducing work-related physical and psychological stressors and strengthening job security and supportive work environments to promote metabolic health and prevent prediabetes at the population level.

Ethical declarations

The study protocol was approved by the Ethics Committee of Guilan University of Medical Sciences

(IR.GUMS.REC.1397.346). Written informed consent was obtained from all participants after they were provided with a clear explanation of the study's purpose and significance. To ensure confidentiality, participant information was anonymized using coded identifiers, and no names or personal identifiers were recorded on the questionnaires.

Conflict of interest

No potential conflict of interest was reported by the authors.

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Authors' contributions

M.A and F.J participated in the research design. F.J, S.Y and F.MG participated in writing the first draft. F.J, Z.AR,F.J and F.MG participated in the performance of the research and data collection. F.J and S.H participated in data analysis. All authors reviewed and confirmed the final manuscript.

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Declaration of using generative AI and AI-assisted technologies

We used ChatGPT to improve the grammar and language of the manuscript, and all authors reviewed and evaluated the final version.

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