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Intentional Hyperglycemia at work, Glycemic Control, Work-related Diabetes Distress and Work Ability among Workers with Diabetes

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Abstract

Background. Work life of individuals with diabetes differs from that of those without diabetes. Work may interfere with diabetes self-management tasks, resulting in intentional hyperglycemia at work (IHW) and poor glycemic control. Diabetes affects work productivity due to work-related diabetes distress (WRDD) and impaired work ability (WA).

Objectives. To estimate the prevalence and identify the predictors of always high, poor/very poor glycemic control, high WRDD and poor/moderate WA among workers with diabetes.

Methodology. A cross-sectional study was done at the Specialized Medical Hospital Mansoura University, which included 323 working patients with diabetes. They were subjected to personal interviews to collect socio-demographic data, occupational, diabetes and other pertinent medical histories. Questionnaires for measuring IHW, WRDD and WA were completed. Clinical and A1c data were obtained from their records.

Results. The prevalence of always high IHW, poor/very poor glycemic control, high WRDD and poor/moderate work ability was: 23.8%, 60.1%, 34.7% and 74.6%, respectively. The predictors of always high IHW were: 1) below university education; 2) treatment with insulin only or combined with oral drugs; and 3) high WRDD. The predictors of poor/very poor glycemic control were urban residence, always and almost high IHW. The predictors of high WRDD were mentally-requiring jobs or both mentally- and physically-requiring jobs, duration of diabetes greater than 14 years and treatment with insulin. The predictors of poor/moderate WA were 'high' WRDD, 'almost high' and 'high a few times' IHW ratings.

Conclusions. Most of the studied population suffered mainly from poor/very poor glycemic control and poor/moderate work ability, while a lower proportion had high WRDD. This highlighted the need for workplace modifications and interventions to help workers with diabetes control their diabetes, improve their work ability and reduce WRDD to increase productivity.

Key words: glycemic control, work ability, intentional hyperglycemia, work-related diabetes stress, work, diabetes

INTRODUCTION

Many members of the workforce suffer from Diabetes mellitus(DM) and its complications worldwide. Although the American Diabetes Association (ADA) recommends that any qualified person has the right to join any job whether they have diabetes or not, employers still prioritize health status among the qualifications. Solving this problem is achieved through personally assessing each employee and their ability to do the job requirements safely and effectively, regardless of diabetes status.[1] Work life of working individuals with diabetes differs from work life of the general population without diabetes as the daily burden of disease management negatively affects work opportunities and choices.[2] Work is also affected by factors influencing illness perceptions and self-care practices of workers and employees with diabetes.[3]

There is a reciprocal relationship between work and diabetes through work-related diabetes distress (WRDD), which is one of the psychosocial concerns reflecting how often working adults with diabetes are worried about the ability to do their jobs because of diabetes.[4] Similarly, diabetes may affect work ability.[5] Also, work may interfere with diabetes self-management tasks such as controlling the blood glucose at recommended levels to prevent or delay complications.[6]

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As efforts towards the investigation of the relationship between diabetes mellitus and work are few in Egypt, this study will highlight some of the effects of working with diabetes and how it affects workers' health and working ability.

OBJECTIVES

To estimate the prevalence and identify predictors of always high intentional hyperglycemia at work (IHW), poor/very poor glycemic control, high work-related diabetes distress and poor/moderate work ability.

Population and methods

This cross-sectional study was done in the Specialized Medical Hospital, Mansoura University, from April 2022 to February 2023.

Inclusion criteria

The study included adult outpatients with diabetes who were working during the study period and who agreed to participate in the study.

Exclusion criteria

Patients who worked for ≤1 year only and were only recently diagnosed with diabetes(for ≤1 year only) were excluded from the study
A pilot study was done on 65 patients (not included in the full-scale study) to test questionnaire applicability, tool reliability and estimate sample size.

Sample size

To estimate the prevalence of IHW in the target population, a minimum sample size of 318 patients was required. This calculation was based on the sample size formula for estimating a population proportion and was determined using the following information: 1) an anticipated prevalence rate of 21.5%, derived from a previous pilot study; 2) a confidence level of 97%; and 3) a precision level of 5%. The sample size was computed using the Open Epi website.[7]

Data collection

Sampling method

All outpatients with diabetes who accepted to participate, fulfilled the inclusion criteria of having diabetes for more than one year and were also working were asked to complete a specially designed questionnaire covering:

A. ***The socio-demographic data*** (age, sex, marital status, educational level and residence), occupational history (job title, job duration, working hours/day, job requirement, shift work) and diabetes history (type, duration, treatment)
B. ***Tools:***

Intentional hyperglycemia at work (IHW)

Intentional hyperglycemia at work refers to the intention of the worker/employee with diabetes to maintain a high blood glucose level at work. Intentional hyperglycemia was assessed using a single item. Respondents were asked to rate how often they intended to maintain high blood glucose levels at work, using a 5-point Likert scale from "never" to "always." This measure has been validated in a previous survey among the adult working population with diabetes[4] and through qualitative research.[3]

Glycemic control

The last reported glycosylated hemoglobin (A1c) level was abstracted from the medical record and classified into good glycemic control = A1c <7%, fair control = A1c 7–8% and poor control = A1c > 8.0%. An A1c cut-off value of ≥9% was used to represent very poor control.[8]

Work-related diabetes distress (WRDD)

The respondents were asked to rate how often they worried about their ability to do their job due to their diabetes and how often they became exhausted by the need to reconcile their work with their diabetes. On a scale of 1–3 (never, sometimes, often), a sum score was calculated. The median was taken as an arbitrary cut-off point. Higher scores indicated higher WRDD.[4]

For IHW and WRDD, **the adverbs of how often an action was done are operationally defined as: always** (doing an action 100% of the time, all the time with no fail); **always high** (75-99% most of the time it happens); **almost high** (50-74% indicating a habit that is usual or common); **high a few times** (does action 25-49% of the time; **rarely high** (1-25% of the time); and **never** (the opposite of always; doing action 0% of the time or not at all).

Work Ability (WA)

Work ability refers to the ability to function well at work or achieve expected work goals, measured by the Work Ability Index (WAI), a self-report assessment tool comprised of seven items.[9,10]

Item 2 denotes work ability in relation to the demands of the job. For physically demanding work, the work ability score is multiplied by 1.5, and the work ability score for mentally demanding work is multiplied by 0.5. For mentally demanding work, the work ability score for the physical demands of the job is multiplied by 0.5, and the work ability score for the mental demands of the job is multiplied by 1.5. For work that is both physically and mentally demanding, the work ability score remains unchanged. For item 3 (number of current diseases diagnosed by a physician), scoring is as follows: 5 or more diseases = 1 point, 4 diseases =2 points, 3 diseases = 3 points, 2 diseases = 4 points, 1 disease = 5 points, no disease = 7 points (only diseases diagnosed by a physician are counted). For item 7 (mental resources), it is divided into three questions that are added together, and the sum is modified as follows: Sum of 0–3 = 1 point, 4 – 6 = 2 points, 7–9 = 3 points and

10–12 = 4 points. The WAI score is the sum of the seven scores (range 7–49). WAI scores are interpreted such that work ability is poor (7–27), moderate (28–36), good (37–43) or excellent (44–49).[11,12]

The English versions of the three tools (IHW, WRDD and WAI) were forward translated into the Arabic language by two translators producing the initial version. This initial version was backtranslated into English by another two bilingual translators who were unaware of the original version. A few discrepancies were agreed upon by consensus to get the final Arabic version.

The content validity of the WRDD and WAI Arabic was tested by a jury of 10 experts (professors in Public Health and Endocrinology). The content validity index (CVI) per item for WRDD ranged from 0.7 to 1.0 for both relevance and clarity, while CVI per expert ranged from 0.6 to 1.0 for both relevance and clarity. The content validity index (CVI) per item for WAI ranged from 0.8 to 1.0 for both relevance and clarity, while CVI per expert ranged from 0.63 to 1.0 for both relevance and clarity.

To test the reliability of the WRDD and WAI Arabic, the final versions were tested in the pilot study, and Cronbach's α reliability coefficients were 0.766 and 0.751, respectively. Data collection included interviews with patients and the collection of clinical data from their records.

Data analysis

Frequencies and percentages were computed to describe the responses to categorical variables measured in the study. To answer the study objectives, the point and 95% confidence interval (CI) estimates of the prevalence of IHW were computed. Furthermore, logistic regression analyses were performed to identify the predictors of the IHW, poor glycemic control, WRDD and poor WA among the patients. The chi-square test and simple logistic regression were performed for the bivariate analysis to ascertain which variables should be included in the multiple logistic regression model. After this, variable selection was performed using the forward selection method. The probability of entering the model was set at 0.05. Likewise, the significance level for all the hypothesis tests performed was 0.05. The crude odds ratio (COR) and adjusted odds ratio (AOR) were reported along with their corresponding 95% CIs. No imputation was performed in this study. All the analyses were conducted using SPSS software (version 17.0 for Windows; SPSS Inc., Chicago, IL, USA).

Ethical considerations

Informed verbal consent was obtained from each participant sharing in the study after assuring confidentiality. The data collection and examination were done by the investigator in privacy. The study proposal was approved by the Institutional Research Board (IRB): R.22.04.1673.

Table 1. Socio-demographic, occupational and diabetes characteristics among the study population

Characteristics	Total No. (%)
Overall	323 (100.0)
Age (years)	
20-55	214 (66.3)
≥56	109 (33.7)
Mean ±SD	49.9 ± 9.7
Sex	
Male	216 (66.9)
Female	107 (33.1)
Marital status	
Married	277 (85.8)
[§]Unmarried	46 (14.2)
Residence	
Urban	161 (49.9)
Rural	162 (50.1)
Education	
Below University	225 (69.7)
University and above	98 (30.3)
Job requirement	
Physical	29 (8.9)
Mental	31 (9.6)
Both	263 (81.5)
Working years	
≤10	54 (16.7)
>10	269 (83.3)
Mean ± SD	24.8 ± 12.3
Working hours	
≤8	227 (70.3)
>8	96 (29.7)
Mean ±SD	8.3 ± 2.4
Night shift	
Yes	69 (21.4)
No	254 (78.6)
Diabetes Mellitus	
Type 1	116 (35.9)
Type 2	207 (64.1)
Diabetes duration (years)	
≤14	165 (50.1)
>14	158 (49.9)
Mean ± SD	14.1 ± 8.5
Family history	
Positive	191 (59.1)
Negative	132 (40.9)
Treatment	
Oral	94 (29.1)
Insulin	174 (53.9)
Both	55 (17.0)

[§]Unmarried: single or widow or divorced

RESULTS

Table 1 shows that most of the participants were males, ages 20 to 55 years, married and educated below university (66.9%,66.3%, 85.8% and 69.7%, respectively). Most of the participants worked ≤8 hours per day for more than 10 years, without night shifts in jobs requiring both physical and mental capacities (70.3%,83.3%,78.6% and 81.5%, respectively). The majority of the patients had type 2 diabetes, and about half of the participants had diabetes for ≤14 years, had a positive family history of diabetes and received insulin alone for treatment at 50.1%,59.1% and 53.9%, respectively.

Table 2 shows that the majority of patients had poor glycemic control defined as an HbA1c greater than 8% (60.1%), almost and always with IHW (52%), had low WRDD (65%), and poor/moderate work ability (74.6%).

Table 2. Distribution of IHW, glycemic control, WRDD and work ability among the study population

Outcome	323 (100) N (%)	(95% CI) of proportion
IHW		
always high	77 (23.8)	(19.2-28.5)
almost high	92 (28.5)	(23.6-33.4)
high few times	92 (28.5)	(23.6-33.4)
rarely high	38 (11.8)	(11.8-15.3)
never high	24 (7.4)	(4.6-10.3)
Glycemic Control		
good (A1c <7%)	48 (14.9)	(11.0-18.7)
fair (A1c 7–8%)	81 (25.1)	(20.4-29.8)
poor, very poor (A1c >8.0%)	194 (60.1)	(54.5-65.4)
WRDD		
Low (1-4)	211 (65.3)	(60.1-70.5)
High (5-6)	112 (34.7)	(29.5-39.9)
WA		
poor/moderate (7-36)	241 (74.6)	(69.5-79.3)
good/excellent (37-49)	82 (25.4)	(20.6-30.1)

Table 3 shows that the overall prevalence of always high IHW was 23.8% (95% CI [19.2,28.5]). The significant independent predictors of always high IHW among participants were: 1) being educated below university (AOR: 2.1,95% CI [1.1, 3.9]), 2) treated with insulin alone or combined with oral drugs (AOR: 3.1,95% CI [1.4, 6.8] and AOR: 4.2,95% CI [1.7-10.8], respectively) and high WRDD (AOR: 2.5,95% CI [1.5, 4.5]).

Table 4 shows that the overall prevalence of poor glycemic control was 60.1% (95% CI [54.5-65.4]). The significant independent predictors of poor/very poor glycemic control among participants were the following: living in an urban area (AOR: 1.8,95% CI [1.1, 2.9]), always high IHW (AOR:5.6,95% CI [2.0, 15.2]) and almost high IHW (AOR:3.8,95% CI [1.4, 10.0]).

Table 5 shows that the overall prevalence of high WRDD was 34.7% (95% CI [29.5,39.9]). The significant independent

Table 3. Factors associated with and independent predictors of the always high IHW

Characteristics	Total No.	IHW Always high No. (%)	Test of significance *P* value	COR (95% CI)	Regression analysis	
Overall	323	77 (23.8)		(19.2-28.5)	*P*	AOR (95% CI)
Age (years)			*P*=0.9			
20-55 (r)	214	51 (23.8)		Referent		
≥56	109	26 (23.9)		1.1 (0.6-1.7)		
Sex			*P*=0.3			
Male (r)	216	48 (22.2)		Referent		
Female	107	29 (27.1)		1.3 (0.8-2.2)		
Marital status			*P*=0.7	1		
Married (r)	277	65 (23.5)		1.2 (0.6-2.4)		
§Unmarried	46	12 (26.1)				
Residence			*P*=0.3			
Urban (r)	161	34 (21.1)		Referent		
Rural	162	43 (26.5)		1.4 (0.8-2.3)		
Education			*P*=0.02		0.02	
Below University	225	62 (24.3)		2.1 (1.13-3.9)		2.1 (1.1-3.9)
University and above (r)	98	15 (15.3)		Referent		Referent
Job requirement						
Physical (r)	29	5 (17.2)	*P*=0.6	Referent		
Mental	31	7 (22.6)	*P*=0.4	1.4 (0.4-5.0)		
Both	263	65 (24.7)		1.6 (0.6-4.3)		
Working years			*P*=0.5			
≤10 (r)	54	11 (20.4)		Referent		
>10	269	66 (24.5)		1.3 (0.6-2.6)		
Working hours			*P*=0.6			
≤8	227	56 (24.7)		1.2 (0.7-2.1)		
>8 (r)	96	21 (21.9)		Referent		
Night shift			*P*=0.9			
Yes	69	17 (24.6)		1.1 (0.6-1.9)		
No (r)	254	60 (23.6)		Referent		
Diabetes Mellitus			*P*=0.2			
Type 1 (r)	116	23 (19.8)		Referent		
Type 2	207	54 (26.1)		1.4 (0.8-2.4)		
Diabetes duration (years)			*P*=0.06			
≤14 (r)	165	32 (13.9)		Referent		
>14	158	45 (28.5)		1.7 (1.0-2.8)		
Family history			*P*=0.7			
Positive	191	47 (24.6)		1.1 (0.7-1.9)		
Negative (r)	132	30 (22.7)		Referent		
Treatment						
Oral (r)	94	9 (9.6)	*P*≤0.001	Referent	0.004	Referent
Insulin	174	52 (29.9)	*P*=0.002	4.0 (1.9-8.6)	0.002	3.1 (1.4-6.8)
Both	55	16 (29.1)		3.9 (1.6-9.5)		4.2 (1.7-10.8)
WRDD			*P*≤0.001			
High	112	42 (37.5)		3.0 (1.8-5.1)	0.001	2.5 (1.5-4.5)
Low (r)	211	35 (16.6)		Referent		Referent
Median (min-max)	4 (2-6)					

§Unmarried: single or widow or divorced, (r) constant

predictors of high WRDD among participants were mental job requirement alone (AOR: 4.0, 95% CI [1.1, 15.2]), or combined mental and physical requirement (AOR: 3.2, 95% CI [1.1-9.8]), duration of diabetes >14 years (AOR: 1.8, 95% CI [1.05, 2.9]) and treatment with insulin (AOR: 2.0, 95% CI [1.02, 3.7])

Table 6 shows that the overall prevalence of poor/moderate work ability was 74.6% (95% CI [69.5, 79.3]). The significant independent predictors of poor/moderate WA among participants were high WRDD (AOR:13.2,95% CI [4.6-37.8]), IHW always high (AOR(95%CI): 5.8(2.1-15.8)], almost high [AOR (95%CI): 4.5(1.8-11.7)] and high few times {AOR(95%CI): 3.2(1.3-7.9)].

DISCUSSION

The present study revealed that the prevalence of patients who intended to keep their blood glucose level at work (IHW) always high was 23.8%, which can be explained by the fear of hypoglycemia at the workplace or "strategic non-compliance."[13] However, lower rates (1.6% and 4.6%) were reported among workers with diabetes in Denmark[14] and Finland,[4] respectively. The discrepancy between the prevalence in the current study and the previous ones could be due to the difference in health knowledge, lifestyle and income between a developing country in Africa and developed Europe.

Table 4. Factors associated with and independent predictors of the poor/very poor glycemic control

Characteristics	Total No.	Poor/very poor glycemic control, No. (%)	Test of significance *P* value	COR (95% CI)	Regression analysis	
Overall	323	194 (60.1)		(54.5-65.4)	*P*	AOR (95% CI)
Age (years)			*P*=0.2			
20-55	214	123 (57.5)		1.3 (0.9-2.2)		
≥56 (r)	109	71 (65.1)		Referent		
Sex			*P*=0.2			
Male	216	135 (62.5)		1.4 (0.8-2.2)		
Female (r)	107	59 (55.1)		Referent		
Marital status			*P*=0.7			
Married (r)	277	165 (59.6)		Referent		
§Unmarried	46	29 (63.0)		1.2 (0.6-2.2)		
Residence			*P*≤0.001		0.02	
Urban	161	107 (66.5)		1.7 (1.1-2.7)		1.8 (1.1-2.9)
Rural (r)	162	87 (53.7)		Referent		Referent
Education			*P*=0.3			
Below University	225	139 (61.8)		1.2 (0.8-2.0)		
University and above (r)	98	55 (56.1)		Referent		
Job requirement						
Physical	29	18 (62.1)	*P*=0.4	1.5 (0.5-4.3)		
Mental (r)	31	16 (51.6)	*P*=0.3	Referent		
Both	263	160 (60.8)		1.5 (0.7-3.1)		
Working years			*P*=0.05			
≤10 years	54	39 (72.2)		1.9 (1.01-3.6)		
>10 years (r)	269	155 (57.6)		Referent		
Working hours			*P*=0.7			
≤8 (r)	227	135 (59.4)		Referent		
>8	96	59 (61.5)		0.9 (0.5-1.5)		
Night shift			*P*=0.7			
Yes	69	43 (62.3)		1.1 (0.7-1.8)		
No (r)	254	151 (59.4)		Referent		
Diabetes Mellitus			*P*=0.9			
Type 1	116	70 (60.3)		1.02 (0.6-1.6)		
Type 2 (r)	207	124 (59.9)		Referent		
Diabetes duration (years)			*P*=0.001			
≤14 (r)	165	84 (50.9)		Referent		
>14	158	110 (69.6)		2.2 (1.4-3.5)		
Family history			*P*=0.1			
Positive (r)	191	108 (56.5)		Referent		
Negative	132	86 (65.2)		1.4 (0.9-2.3)		
Treatment						
Oral (r)	94	44 (46.8)	*P*=0.002	Referent		
Insulin	174	112 (64.4)	*P*=0.008	2.1 (1.3-3.4)		
Both	55	38 (69.1)		2.5 (1.3-5.1)		
WRDD			*P*=0.1			
High	112	74 (66.1)		1.5 (0.9-2.4)		
Low (r)	211	120 (56.9)		Referent		
Median (min-max)	4 (2-6)					
IHW						
Always high	77	57 (74.0)	*P*≤0.001	5.7 (2.1-15.3)	0.001	5.6 (2.0-15.2)
Almost high	92	62 (67.4)		4.1 (1.5-10.7)	0.007	3.8 (1.4-10.0)
High few times	92	47 (51.1)	*P*=0.002	2 (0.8-5.3)	0.1	2.1 (0.8-5.3)
Rarely high	38	20 (52.6)	*P*=0.09	2.2 (0.8-6.4)	0.1	2.2 (0.8-6.4)
Never high (r)	24	8 (33.3)	*P*=0.1	Referent		Referent

§Unmarried: single or widow or divorced, (r) constant, ≈ A1c>8.0%

Table 5. Factors associated with and independent predictors of the high WRDD

Characteristics	Total No.	High WRDD No. (%)	Test of significance *P* value	COR (95% CI)	Regression analysis	
Overall	323	112 (34.7)		(29.5-39.9)	***P***	AOR (95% CI)
Age (years)			*P*=0.9			
20-55(r)	214	74 (34.6)		Referent		
≥56	109	38 (34.8)		1.01 (0.6-1.6)		
Sex			*P*=0.3			
Male (r)	216	71 (32.9)		Referent		
Female	107	41 (38.3)		1.3 (0.8-2.1)		
Marital status			*P*=0.2			
Married	277	100 (36.1)		1.6 (0.8-3.2)		
§Unmarried (r)	46	12 (26.1)		Referent		
Residence			*P*=0.1			
Urban (r)	161	49 (30.4)		Referent		
Rural	162	63 (38.9)		1.5 (0.9-2.3)		
Education			*P*=0.07			
Below University	225	85 (37.8)		1.6 (0.9-2.7)		
University and above (r)	98	27 (27.6)		Referent		
Job requirement						
Physical (r)	29	4 (13.8)	*P*=0.03	Referent		Referent
Mental	31	12 (38.7)	*P*=0.01	3.9 (1.1-14.2)	0.04	4.0 (1.1-15.2)
Both	263	96 (36.5)		3.6 (1.2-10.6)	0.04	3.2 (1.1-9.8)
Working years			*P*=0.07			
≤10 years (r)	54	13 (20.4)		Referent		
>10 years	269	99 (36.8)		1.8 (0.9-3.6)		
Working hours			*P*=0.3			
≤8 (r)	227	75 (33.0)		Referent		
>8	96	37 (38.5)		1.3 (0.8-2.1)		
Night shift			*P*=0.9			
Yes	69	24 (34.8)		1.1 (0.6-1.7)		
No (r)	254	88 (34.6)		Referent		
Diabetes Mellitus			*P*=0.001			
Type 1 (r)	116	27 (23.3)		Referent		
Type 2	207	85 (41.1)		2.3 (1.4-3.8)		
Diabetes duration (years)			*P*≤0.001		0.03	
≤14 (r)	165	43 (26.1)		Referent		Referent
>14	158	69 (43.7)		2.2 (1.4-3.5)		1.8 (1.05-2.9)
Family history			*P*=0.7			
Positive	191	68 (35.6)		1.1 (0.7-1.8)		
Negative (r)	132	44 (33.3)		Referent		
Treatment					0.04	
Oral (r)	94	20 (21.3)	*P*≤0.001	Referent		Referent
Insulin	174	77 (44.3)	*P*=0.4	2.9 (1.6-5.2)		2.0 (1.02-3.7)
Both	55	15 (27.3)		1.4 (0.6-3.0)		-

§Unmarried : single or widow or divorced, (r) constant

The current study (Table 3) found that those patients with education less than the university level had a higher risk of always hyperglycemia at work, which is associated with worse glycemic control.[5] This finding could result from insufficient health knowledge as a lower educational level hinders the patient's ability to care for their diabetes. This result was supported by a study in the US, which detected that the patients with diabetes with low educational levels had a negative effect on their blood glucose level.[15]

Also, the present data showed that working adults treated with insulin only or combined with oral drugs have a higher risk of always having high blood glucose at work and this can be related to skipping insulin doses because of the unavailability of either a private, clean place to do the injection or an insulated carrier or fridge to preserve it.[16] Similarly, in Ethiopia, patients treated with insulin only or combined with oral drugs were at greater risk of poor glycemic control than those on oral anti-diabetic drugs alone.[17]

Current data also found that high WRDD increased the risk of hyperglycemia at work. Having high WRDD is a source of psychological and emotional stress that may contribute to hyperglycemia among patients with diabetes, and this was in accordance with the study finding that high WRDD resulted in more frequent IHW.[5] Similarly, the association between WRDD and IHW was detected in the Finnish study.[4]

The prevalence of poor/very poor glycemic control among the workers with diabetes in the current study was 60.1%, and this may be due to either non-compliance with medications or poor diet. Studies in Ethiopia[18] and Amman Jordan[19] have shown the prevalence of poor/very poor glycemic control was 61.92% and 65.1%, respectively. In contrast, studies in Mumbai found a higher prevalence of poor/very poor glycemic control (91.8%) due to a lack of self-care management behaviors in addition to a long duration of diabetes.[20] The current study revealed that the risk of poor/very poor glycemic control was higher among urban residents and can be attributed to unhealthy lifestyles and diets. This finding is consistent with another

study in Saudi Arabia.[21] However, studies in Ethiopia reported that the greater risk of poor glycemic control was among patients living in rural areas than those living in urban Ethiopia.[22]

The present work reflected a higher risk of poor/very poor glycemic control among those with always or almost high IHW. In agreement with this finding, studies proved the association between poor/very poor glycemic control and IHW among Finnish workers.[4] However, a direct relationship between glycemic control and IHW was not established. Instead, an indirect effect through an intermediate pathway through the effect of work-related factors on glycemic control was observed.[5]

The current study showed that the overall prevalence of high WRDD was 34.7%, which is lower than that detected among Finnish workers with diabetes (70%).[4] In this present work, the risk of high WRDD increased among those exposed to mental job requirements alone or combined with physical requirements which were in contrast to studies proving that mental work protects from WRDD.[4]

Table 6. Factors associated with and independent predictors of the poor/moderate WA

Characteristics	Total No.	Poor/ moderate WA¥	Test of significance *P* value	COR (95% CI)	Regression analysis	
Overall	323	241 (74.6)		(69.5-79.3)	*P*	AOR (95% CI)
Age (years)			*P*=0.2			
20-55 (r)	214	155 (72.4)		Referent		
≥56	109	86 (78.9)		1.4 (0.8-2.5)		
Sex			*P* =0.9			
Male (r)	216	161 (74.5)		Referent		
Female	107	80 (74.8)		1.01 (0.6-1.7)		
Marital status			*P*=0.2			
Married	277	210 (75.8)		1.5 (0.8-3)		
§Unmarried (r)	46	31 (67.4)		Referent		
Residence			*P*=0.2			
Urban (r)	161	115 (71.4)		Referent		
Rural	162	126 (77.8)		1.4 (0.8-2.3)		
Education			*P*=0.04			
Below University	225	175 (77.8)		1.7 (1.003-2.9)		
University and above (r)	98	66 (67.3)		Referent		
Job requirement						
Physical (r)	29	18 (62.1)	*P*=0.06	Referent		
Mental	31	26 (83.9)	*P*=0.1	3.2 (0.9-10.7)		
Both	263	197 (74.9)		1.8 (0.8-4)		
Working years			*P*=0.4			
≤10 (r)	54	38 (70.4)		Referent		
>10	269	203 (75.5)		1.3 (0.7-2.4)		
Working hours						
≤8 (r)	227	168 (74.0)	χ^2=0.15	Referent		
>8	96	73 (76.0)	*P*=0.7	1.1 (0.6-1.9)		
Night shift			*P*=0.9			
Yes	69	51 (73.9)		1.1 (0.5- 1.9)		
No (r)	254	190 (74.8)		Referent		
Diabetes Mellitus			*P*=0.03			
Type 1 (r)	116	76 (65.5)		Referent		
Type 2	207	165 (79.7)		1.8 (1.1-2.9)		
Diabetes duration (years)			*P*=0.07			
≤14 (r)	165	116 (70.3)		Referent		
>14	158	125 (79.1)		1.6 (0.9-2.6)		
Family history			*P*=0.3			
Positive (r)	191	139 (72.8)		Referent		
Negative	132	102 (77.3)		1.3 (0.8-2.1)		
Treatment						
Oral	94	66 (70.2)	*P*=0.7	1.1 (0.6-2.3)		
Insulin	174	138 (79.3)	*P*=0.1	1.9 (0.9-3.7)		
Both (r)	55	37 (67.3)		Referent		
Glycemic control			*P*=0.6			
Poor/very poor	194	147 (75.8)		1.2 (0.7-1.9)		
Good/fair (r)	129	94 (72.8)		Referent		
WRDD			*P*≤0.001		≤0.001	
High	112	108 (96.4)		15.8 (5.6-44.6)		13.2 (4.6-37.8)
Low (r)	211	133 (63.0)		Referent		Referent
Median (min-max)	4 (2-6)					
IHW						
Always high	77	64 (83.1)	*P*=0.0003	5.8 (2.1-15.8)	0.001	5.8 (2.1-15.8)
Almost high	92	73 (79.3)	*P*=0.001	4.5 (1.7-11.7)	0.002	4.5 (1.8-11.7)
High few times	92	67 (72.8)	*P*=0.01	3.2 (1.3-7.9)	0.02	3.2 (1.3-7.9)
Rarely high	38	26 (68.4)	*P*=0.08	2.6 (0.9-7.3)	0.08	2.6 (0.9-7.3)
Never high (r)	24	11 (45.8)		Referent		Referent

§Unmarried : single or widow or divorced, (r) constant
¥Poor/ moderate WA: WAI score = 7-36

Also, this study found that those having diabetes for >14 years duration or being treated with insulin had an increased risk of high WRDD. In agreement with our results, studies in India reported that insulin use increased the risk of WRDD.[23] Similarly, studies in Ethiopia found that both the long duration of diabetes >10 years and insulin therapy increased the risk of poor glycemic control,[24] causing higher WRDD.[4]

The present work found that 74.6%of the participants had poor/moderate work ability, which could be attributed to high blood glucose related to poor glycemic control and intentional hyperglycemia at work. Our finding was consistent with a study in Iran, which detected that 75% of the participants had poor/moderate work ability.[25] Similarly, other studies supported our findings.[26,27] The present study found that the predictors of poor/moderate work ability were as follows: high WRDD, always high, almost high or high a few times IHW. These findings were in agreement with a study in Denmark.[5]

Limitations

Since the sample size for this study was computed primarily to estimate the prevalence of IHW among patients, the power of the statistical tests was ascertained to determine possible issues with the external validity of the modeling results. Consequently, post-hoc power analysis showed that most predictors included in the final models had adequate power of 0.80 or higher, except the hypothesis test involving the regression coefficient for education in the IHW model, which only had a power of 0.54. Nevertheless, the CIs for this variable indicate that low education likely increases the odds of having a negative outcome.

CONCLUSIONS

The results from our study demonstrated that most of the studied population had poor/very poor glycemic control and poor/moderate work ability, with a lower proportion having high WRDD. This highlighted the need for workplace modifications and interventions to help workers with diabetes achieve good glucose control, improve their work ability and reduce WRDD to increase production.

Recommendations

Health education must be regularly offered to all patients attending the diabetes clinic, focusing on work life with diabetes. Encouraging communication with the occupational health personnel for minor work modifications to reduce WRDD and to devise means at work to allow space and time for small meals, self-monitoring of blood glucose and/or receiving treatment. Further multicenter studies are recommended to express the magnitude of the problem on a larger scale.

Statement of Authorship
All authors certified fulfillment of ICMJE authorship criteria.

CRediT Author Statement
SSE: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing - original draft preparation, Writing - review and editing, Visualization, Supervision, Project administration, Funding acquisition; **ABEG:** Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Writing - review and editing; **MRGB:** Conceptualization, Resources, Data curation; **AME:** Conceptualization, Investigation, Resources, Data curation

Data Availability Statement
The datasets generated and/or analyzed during the current study are not publicly available due to the privacy of patients attending this hospital but are available from the corresponding author upon reasonable request.

Author Disclosure
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References
1. American Diabetes Association. Diabetes and employment. Diabetes Care. 2009;32 (Suppl 1):S80-4. PMID: 19118292 PMCID: PMC2613588 DOI: 10.2337/dc09-S080
2. Nielsen HB, Ovesen LL, Mortensen LH, Lau CJ , Joensen LE. Type 1 diabetes, quality of life, occupational status and education level –A comparative population-based study. Diabetes Res Clin Pract. 2016;121:62–8. PMID: 27662040 DOI:10.1016/j.diabres.2016.08.021
3. Ruston A, Smith A, Fernando B. Diabetes in the workplace - diabetic's perceptions and experiences of managing their disease at work: A qualitative study. BMC Public Health 2013;13:386. PMID: 23617727 PMCID: PMC3649948 DOI: 10.1186/1471-2458-13-386..
4. Hakkarainen P, Moilanen L, Hänninen V, Heikkinen J, Räsänen K. Work-related diabetes distress among Finnish workers with type 1 diabetes: a national cross-sectional survey. J Occup Med Toxicol. 2016;11:11. PMID: 27006684PMCID: PMC4802881 DOI: 10.1186/s12995-016-0099-4
5. Hansen UM, Skinner T, Olesen K,Willaing I. Diabetes distress, intentional hyperglycemia at work, and glycemic control among workers with type 1 diabetes. Diabetes Care, 2019;42(5):797-803. PMID: 30765430 DOI: 10.2337/dc18-1426
6. Fullerton B, Jeitler K, Seitz M, Horvath K, Berghold A, Siebenhofer A. Intensive glucose control versus conventional glucose control for type 1 diabetes mellitus. Cochrane Database Syst Rev. 2014;2014(2):CD009122. PMID: 24526393 PMCID: PMC6486147 DOI: 10.1002/14651858.CD009122.pub2
7. Open Source Epidemiologic Statistics for Public Health, Version. www.openepi.com/SampleSize/SSPropor.htm
8. Afroz A, Ali L, Karim MN, et al. Glycaemic control for people with type 2 diabetes mellitus in Bangladesh - an urgent need for optimization of management plan. Sci Rep, 2019;9(1):10248. PMID: 31308457 PMCID: PMC6629620 DOI: 10.1038/s41598-019-46766-9
9. Ilmarinen J.Work ability—a comprehensive concept for occupational health research and prevention. Scand J Work Environ Health. 2009;35(1):1-5. PMID: 19277432 DOI: 10.5271/sjweh.1304.
10. Ilmarinen J, Tuomi K. Past, present and future of work ability. People Work – Res Rep J Hels Fin; Finn Inst Occup Health. 2004;65:1-25.
11. Sjögren-Rönkä T, Ojanen MT, Leskinen EK, Mustalampi ST,Mälkiä EA. Physical and psychosocial prerequisites of functioning in relation to work ability and general subjective well-being among office workers. Scand J Work Environ Health. 2002;28(3):184-90. PMID: 12109558 DOI: 10.5271/sjweh.663.
12. Ilmarinen J. The work ability index (WAI). Occup Med. 2007; 57(2):160. DOI: 10.1093/occmed/kqm008
13. Campbell R, Pound P, Pope C, et al. Evaluating meta-ethnography: A synthesis of qualitative research on lay experiences of diabetes and diabetes care. Soc Sci Med. 2003;56(4):671-84. PMID: 12560003 DOI: 10.1016/s0277-9536(02)00064-3
14. Hansen UM, Olesen K, Browne JL, Skinner TC,Willaing I. A call for inclusion of work-related diabetes distress in the spectrum of diabetes management: Results from a cross-sectional survey among working people with type 1 diabetes. Diabetes Res Clin Pract. 2018;140: 139-47. PMID: 29604390 DOI: 10.1016/j.diabres.2018.03.040
15. Trief PM, Aquilino C, Paradies K, Weinstock R. Impact of the work environment on gylcaemic control and adaptation to diabetes. Diabetes Care. 1999;22(4):569-74. PMID: 10189533 DOI: 10.2337/diacare.22.4.569

16. Sorli C, Heile MK. Identifying and meeting the challenges of insulin therapy in type 2 diabetes. J Multidiscip Healthc. PMID: 25061317 PMCID: PMC4086769 DOI: 10.2147/JMDH.S64084
17. Nigussie S, Birhan N, Amare F, Mengistu G, Adem F, Abegaz TM. Rate of glycemic control and associated factors among type two diabetes mellitus patients in Ethiopia: across-sectional study. PloS One. 2021;16(5):e0251506. PMID: 33974654 PMCID: PMC8112661 DOI: 10.1371/journal.pone.0251506
18. Bitew ZW, Alemu A, Jember DA, et al. Prevalence of glycemic control and factors associated with poor glycemic control: asystematic review and meta-analysis. Inquiry. 2023;60:469580231155716. PMID: 36852627 PMCID: PMC10071101 DOI: 10.1177/00469580231155716
19. Khattab M, Khader YS, Al-Khawaldeh A, Ajlouni K. Factors associated with poor glycemic control among patients with type 2 diabetes. J Diabetes Complication.2010;24(2):84-9. PMID: 19282203 DOI: 10.1016/j.jdiacomp.2008.12.008
20. Kakade AA, Mohanty IR, Sandeep Rai. Assessment of factors associated with poor glycemic control among patients with type II diabetes mellitus. Integr Obesity Diabetes 2018;24(2):84-9 DOI: 10.15761/IOD.1000209
21. Alzaheb RA,Altemani AH. The prevalence and determinants of poor glycemic control among adults with type 2 diabetes mellitus in Saudi Arabia. Diabetes Metab Syndr Obes. 2018;11:15-21. PMID: 29430192 PMCID: PMC5797462 DOI: 10.2147/DMSO.S156214
22. Shita NG, Iyasu AS. Glycemic control and its associated factors in type 2 diabetes patients at Felege Hiwot and Debre Markos Referral Hospitals. Sci Rep. 2022;8;12(1):9459. PMID: 35676526 PMCID: PMC9177638 DOI: 10.1038/s41598-022-13673-5
23. Gupta S, Solomon L, Jacob JJ. Diabetic distress and work-related stress among individuals with type 2 diabetes mellitus. Clinical Diabetology. 2022;11(1):11-4. DOI: 10.5603/DK.a2022.0005
24. Abera RG, Demesse ES, Boko WD. Evaluation of glycemic control and related factors among outpatients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia: a cross-sectional study. BMC EndocrDisord. 2022;22(1):54. PMID: 35249547 PMCID: PMC8898656 DOI: 10.1186/s12902-022-00974-z
25. Motamed B, Mosafer A, Attarchi M. Assessment of the work ability related factors in diabetic patients. Heliyon. 2022;8(11):e11467. PMID: 36387515PMCID: PMC9647500 DOI: 10.1016/j.heliyon.2022.e11467
26. Wong E, Backholer K, Gearon E, Harding J, et al. Diabetes and risk of physical disability in adults: a systematic review and meta-analysis. Lancet Diabetes Endocrinol. 2013;1(2):106-14. PMID: 24622316 DOI:10.1016/S2213-8587(13)70046-9
27. Breton MC, Guénette L, Amiche MA, Kayibanda JF, Grégoire JP, Moisan J. Burden of diabetes on the ability to work: a systematic review. Diabetes Care. 2013;36(3):740-9. PMID: 23431092 PMCID: PMC3579337 DOI: 10.2337/dc12-0354