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The Prevalence of Prediabetes in Healthcare Professionals assessed based on Glycated Hemoglobin Levels

Witold Rongies[1,2], Monika Wolska[3], Katarzyna Strzałka-Goc[4], Bartosz Słomka[1*], Przemysław Krasnodębski[5], Włodzimierz Dolecki[5] and Krzysztof Dembe[5]

[1]Department of Physiotherapy, Rehabilitation Division, II Faculty of Medicine, Medical University of Warsaw, Poland
[2]Department of Rehabilitation, Independent Public Central Clinical Hospital in Warsaw, Poland
[3]Medical University of Warsaw, Poland
[4]Center of Rehabilitation Constance Care Konstancin, Poland
[5]Department of Internal Diseases and Diabetology, Medical University of Warsaw, Poland

*Corresponding author: Bartosz S, Department of Physiotherapy, Rehabilitation Division, II Faculty of Medicine, Medical University of Warsaw, Poland, Tel: +48 508 391 725; E-mail: bartosz.slomka@wum.edu.pl

Abstract

Background: Due to its significant prevalence, incidence, and economic burden, type 2 diabetes mellitus has been the subject of a number of economic analyses and epidemiological studies. It is believed that it may take as many as 12 years from the onset of the first sign of type 2 diabetes mellitus to the time of diagnosis. Thus, there is a potential benefit in conducting screening tests in the interim to help detect prediabetes before type 2 diabetes mellitus fully develops.

Objective: To assess the risk of type 2 diabetes mellitus in a randomly selected group of healthcare professionals employed at one of Warsaw hospitals by measuring glycated hemoglobin levels with the A1cNow+ test.

Materials and methods: The study included 465 employees of the Independent Public Central Hospital in Warsaw. The selection of healthcare professionals for the study was random. Inclusion criteria: healthcare professionals employed at the Independent Public Central Hospital in Warsaw; no awareness of having type 2 diabetes mellitus. The largest study subgroup (63.4%) were nurses, followed by physicians 13.5%, physiotherapists (10.3%), and orderlies (6.6%). All subjects underwent glycated hemoglobin level measurement with the Bayer A1cNow+ system. The statistical analysis was conducted with Statistica 10.0. Apart from this, Mann-Whitney's U test, Kruskal-Wallis's test (post hoc Dunn's test), Spearman's rank correlation coefficient and test for significance. The adopted significance level was α=0.05.

Results: The study group was evaluated for metabolic disturbances (expressed in the form of HbA1c levels) with an American Diabetes Association-approved classification. The results indicated that a vast majority of the evaluated healthcare personnel (383 people; 82.4%) had normal glycated hemoglobin levels. The remainder of the study group showed carbohydrate metabolism disturbances. The range of glycated hemoglobin levels (5.7–6.4%) found in 73 people (15.7%) suggested an increased risk for diabetes. As a result of the study, as few, or as many, as 9 people (1.9%) were diagnosed with diabetes (initial diagnosis).

Conclusions: Most of the evaluated healthcare professionals (82.4%) showed no evidence of being at risk for type 2 diabetes mellitus. Only 17.6% of respondents were unaware of their metabolic disturbances. The study demonstrated a positive correlation between body mass index values and glycated hemoglobin levels in the evaluated group of healthcare professionals (R=0.3), which was similar to that found in the general population.

Keywords: HbA1c; A1cNow+ test; Diabetes mellitus; Glucose; Health care; Screening; Health care workers

Introduction

Type 2 diabetes mellitus (T2DM) is one of the main medical problems in a number of countries in the world, both in terms of its socioeconomic and healthcare impact. T2DM may remain asymptomatic for a long time, which means it is often diagnosed only when severe complications have already developed. At present, nearly 50% of patients have at least one complication before being diagnosed. T2DM imposes a number of limitations on the patient's lifestyle, sometimes leading to disability and sometimes – to premature death. Due to its significant prevalence, incidence, and economic burden,

T2DM has been the subject of many economic analyses and epidemiological studies. It is believed that it may take as many as 12 years from the onset of T2DM to the moment the diagnosis is established. Thus, there is a potential benefit in conducting screening tests in the interim to help detect prediabetes before T2DM fully develops. Such a screening test should be brief, not inconvenient for the patient, and highly accurate. Bearing in mind that screening tests are not always conclusive, they are still worth conducting, as they suggest the direction for further diagnostics. Another important element of diabetes prevention, especially T2DM, is health-oriented education of the general public. This is implemented largely by family doctors. However, considering the extent of the need for public education in this field, the help of other healthcare professionals, who are also able to initiate preventive measures and detect the first signs

and symptoms of carbohydrate metabolism disturbances, must be sought. In light of the above, we aimed to assess, in an indirect and practical manner, the knowledge on T2DM in various groups of healthcare professionals by measuring glycated hemoglobin (HbA1c) levels in 465 employees of one of Warsaw hospitals [1-7].

Objective

The study aimed to assess the risk of T2DM in a randomly selected group of healthcare professionals at one of Warsaw hospitals by measuring HbA1c levels with the A1cNow+ test (Bayer HealthCare).

Material and Methods

The study group comprised 465 healthcare professional employees of the Independent Public Central Hospital (SP CSK) in Warsaw. The recruited subjects were selected randomly. Each subject had to meet the following inclusion criteria: being a healthcare professional employed at SP CSK in Warsaw; having no awareness of suffering from T2DM.

The most numerous study subgroup (n=295) were nurses, who constituted 63.4% of the entire study group. The second most numerous subgroup (n=63) were physicians at 13.5%, followed by physiotherapists (n=48; 10.3%) and orderlies (n=30; 6.6%). The least numerous subgroup (n=29; 6.2%) comprised "other healthcare professionals," such as medical receptionists and medical secretaries.

The study group included 398 women (85.6%) and 67 men (14.4%). Age data were grouped into 5 ranges, with the largest subgroup (28.2%) aged 40–49 years, followed by 50–59 years (27.7%) and 20–29 years (20.6%), and the smallest subgroup (3%) aged ≥ 60 years.

Study design

The study protocol was approved by the Institutional Review Board at the Medical University of Warsaw on May 7, 2013 (KB/152/2013). The study period was from May to December 2013. Each subject was informed of the objectives, methods, benefits, possible discomforts, and other important aspects of the study. All subjects who provided written informed consent underwent testing of HbA1c levels with the use of the Bayer HealthCare A1cNow+ system. Subsequently, all subjects completed a questionnaire on their anthropometric data (weight, height) and information on their medical profession. Only fully and correctly completed questionnaires were included in the analysis.

Measuring HbA1c levels with the Bayer A1cNow+ system

Glycated hemoglobin (HbA1c) is a product of non-enzymatic protein glycation and the quantity formed depends on the amount of the available substrates: blood hemoglobin A and blood glucose. HbA1c is produced continuously throughout the lifespan of a red blood cell, which is approximately 120 days. HbA1c levels are proportional to those of serum glucose. Thus, HbA1c testing can help retrospectively assess the average serum glucose levels in the period of up to 2–3 months prior to the test. HbA1c is considered to be an excellent test parameter and HbA1c testing is an established standard of assessment in diabetic patient monitoring [1-3]. Novel technical solutions employed in the Bayer A1cNow+ system help measure HbA1c levels either in venous or capillary blood. The Bayer HealthCare A1cNow+ system, which was designed for rapid and accurate HbA1c testing, meets the National Glycohemoglobin

Standardization Program (NGSP) requirements. Moreover, the obtained results can be interpreted based on the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) standard. Results obtained with the HbA1c measuring system used in this study have been shown to be highly consistent (approximately 99%) with those obtained via a reference method [3].

Our assessments involved 5 µl samples of capillary or venous blood collected via a fingertip prick with a disposable lancet. Each test was conducted with a disposable kit opened directly in front of the subject immediately prior to blood sample collection. Each collected blood sample was placed in a A1c Now+ system capillary tube, which initiated the HbA1c level measurement. Test results were ready 5 minutes later. The obtained HbA1c level values were analyzed according to American Diabetes Association (ADA) guidelines. The findings served as the basis for assessing the risk of diabetes. Diabetes mellitus was diagnosed if HbA1c levels were equal to or greater than 6.5%. Subjects with HbA1c levels in the 5.7–6.4% range were considered to be at high risk for diabetes (Table 1) [2-12].

HbA1c levels (criteria)	Study group (n=465)	%
Normal<5.7%	383	82.4%
at risk for diabetes 5.7-6.4%	73	15.7%
diagnosed with diabetes ≥ 6.5%	9	1.9%

Table 1: Diabetes risk classification (according to ADA) based on HbA1c levels.

A 1% change in HbA1c corresponds to a mean change in blood glucose levels by approximately 30 mg/dl. Rising serum glucose levels and long-term hyperglycemia lead to an increase in HbA1c levels. These unfavorable changes closely correlate with higher risk for early and long-term diabetes complications [2].

Statistical Analysis

The statistical analysis was conducted with Statistica 10.0. We conducted a descriptive analysis of study results. The subsequent Shapiro-Wilk test revealed non-normal data distribution. The next step involved the use of non-parametric tests (Friedman's ANOVA and Wilcoxon's tests) for dependent variables. The Spearman correlation test was used to demonstrate correlations between the evaluated variables. The chi-square test for independence was used to assess the relationship between qualitative variables. In all analysis the 0.05 significance level was assumed. Qualitative variables were presented as absolute values and percent values in reference to the total study group.

Results

The mean age in the study group was 42.1 ± 11.3 years. The differences between the first quartile and minimum values and between the maximum and third quartile values were 10 and 24, respectively. This demonstrated the age distribution to be skewed to the right. The mean age was lower than the median, which meant that more than a half of subjects were at an age above the mean value.

The body mass index (BMI) was also evaluated. Twelve respondents, which constituted 2.6% of all the randomly selected healthcare professionals undergoing evaluation, were underweight. A total of 239 subjects (51.4%) exhibited normal body weight (within normal limits),

137 (29.5%) were overweight, and 77 (16.6%) were obese. The minimum BMI value in the study group was 16.7 kg/m^2, and the maximum 44.2 kg/m^2 (mean 25.4 ± 4.5 kg/m^2, median 24.6 kg/m^2). The first and third quartile BMI values were 22.2 kg/m^2 and 27.7 kg/m^2, respectively. Like in the case of age, BMI values also showed a decidedly right-skewed distribution.

The study group was evaluated for metabolic disturbances (expressed in the form of HbA1c levels) with an ADA-approved classification. The results indicated that a vast majority of the evaluated healthcare personnel (383 people; 82.4%) had normal HbA1c levels. The remainder of the study group showed carbohydrate metabolism disturbances. The range of HbA1c levels (5.7–6.4%) found in 73 people (15.7%) suggested an increased risk for diabetes. As a result of the study, as few, or as many, as 9 people (1.9%) were diagnosed with diabetes (initial diagnosis) (Table 1).

The maximum, mean, and minimum HbA1c levels in the evaluated healthcare professionals were 9.6%, 5.4%, and 4.1% respectively. The median and mean values differed only by 0.1%. Quartile values and their respective extremes were: 1 for the minimum and 4 for the maximum, which indicated a right skewed distribution. HbA1c levels showed a lesser variance than other analyzed parameters.

The statistical analysis also included the assessment of any possible effect the individual healthcare professions had on the evaluated variables (age, BMI, HbA1c level). The study group was stratified by the profession and each of these subgroups was individually tested for normality.

This analysis showed normal distribution for all of these variables only in the group of hospital orderlies. Because of the results and the number of professions evaluated, data comparisons were conducted with the Kruskal-Wallis test.

Other medical personnel (medical receptionists and secretaries)

The mean age in this subgroup was 39 ± 11.1 years, with the youngest person 26 and the oldest one 60 years old. The maximum, mean, and minimum HbA1c levels in this subgroup were 6.2%, 5.3%, and 4.7%, respectively, while BMI values were 43 kg/m^2, 25.2 kg/m^2, and 16.4 kg/m^2 respectively (Table 2).

The maximum, mean, and minimum HbA1c levels were 9%, 5.4%, and 4.1% respectively, while BMI values were 44.2 kg/m^2, 25.6 kg/m^2, and 17.6 kg/m^2 respectively (Table 2).

Nurses

The mean age of nurses was 41.8 ± 11.2 years, with the youngest person aged 21 and the oldest one 65 years.

Variables	Physiotherapist Group (n=48)		Physician Group (n=63)		Nurse Group (n=295)		Hospital Orderlies (n=30)		Other Medical Personnel (n=29)	
	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range
Age (yr)	44.8 ± 11.2	26-59	42.1 ± 12.1	25-75	41.8 ± 11.2	21.0-65.0	44.2 ± 10.2	21.0-58.0	39.0 ± 11.1	26-60
BMI (Kg/m2)	24.1 ± 2.4	20.3-33.3	25.1 ± 3.8	17.2-33.06	25.6 ± 4.6	17.6-44.2	26.2 ± 5.3	16.7-38.9	25.2 ± 6.4	16.4-43
HbA1c (%)	5.3 ± 0.3	4.8-6.5	5.5 ± 0.9	4.6-9.6	5.4 ± 0.5	4.1-9.0	5.4 ± 0.3	4.9-6.0	5.3 ± 0.3	4.7-6.2
*SD: Standard Deviation; BMI: Body Mass Index; HbA1c: Glycated hemoglobin										

Table 2: Descriptive statistics in the study groups.

Hospital orderlies

The mean age of orderlies was 44.2 ± 10.2 years, with the youngest person aged 21 and the oldest one 58 years. The maximum, mean, and minimum HbA1c levels in this group were 6.0%, 5.4%, and 4.9%, respectively, while BMI values were 38.9 kg/m^2, 26.2 kg/m^2, and 16.7 kg/m^2 respectively (Table 2).

Profession	n	Mean	p-value
Physiotherapist	48	44.8	
Physician	63	42.1	
Nurse	295	41.8	0.119
Hospital orderlies	30	44.2	
Other personnel	29	39	

Table 3: A comparison of healthcare profession subgroups in terms of age (in years).

Physiotherapists had the highest mean age out of all the evaluated healthcare professionals. The statistical analysis showed no significant differences between subgroups in terms of age (p=0.119) (Table 3). Orderlies had the highest mean BMI value. The statistical analysis showed no statistically significant differences between the healthcare professional subgroups in terms of BMI (p=0.261) (Table 4).

Profession	n	Mean	p-value
Physiotherapist	48	24.1	
Physician	63	25.1	
Nurse	295	25.6	0.261
Orderly	30	26.2	
Other personnel	29	25.2	

Table 4: A comparative analysis of the evaluated healthcare profession subgroups in terms of BMI (kg/m^2).

Mean HbA1c levels were similar in all healthcare professional subgroups. The highest HbA1c level was observed in the physician group and the lowest in the nurse group. The analysis showed no differences between the evaluated medical professions in terms of HbA1c levels (p=0.904) (Table 5).

Profession	n	Mean	p-value
Physiotherapist	48	5.3	
Physician	63	5.5	
Nurse	295	5.4	0.904
Orderly	30	5.4	
Other personnel	29	5.3	

Table 5: A comparative analysis of the evaluated healthcare professional subgroups in terms of HbA1c levels (%).

Discussion

The delay in diagnosing T2DM is a significant problem of modern medicine. T2DM may be asymptomatic for many years. Therefore, it is often detected incidentally during routine diagnostic evaluations [3,13]. Considering the high cost of treatment, which is mostly due to diabetic complications, it seems necessary to introduce preventive programs [14].

Promoting a "healthy lifestyle" should be the primary objective of public healthcare. Health-oriented behavior of people in certain professions, especially healthcare, should serve as an example for the general population. The use of primary prevention (e.g. lifestyle changes, eliminating risk factors for diabetes) would likely contribute to limiting epidemiological increase in T2DM prevalence. Public awareness and health-related knowledge play an essential role in this respect. Based on this study, healthcare professionals seem to have extensive knowledge and awareness in the field of "a healthy lifestyle" [15-17]. Healthcare professionals should exhibit behaviors reflecting their health awareness; however, the reality is often quite different. There have been few studies in this professional group. This may be due to the fact that lifestyles of healthcare professionals are associated with high physical and psychological stress and limited free time [16]. This may be responsible for this professional group's reluctance to participate in studies and, consequently, the scarcity of research on this part of the population.

The main aim of this study was to assess the risk of T2DM in different professions by analyzing randomly selected healthcare professionals employed at SP CSK in Warsaw. The study group evaluated in terms of two parameters: the rates of metabolic disturbances (expressed in terms of HbA1c levels) and body weight abnormalities as one of the key risk factors for T2DM. The first parameter was evaluated via a diabetes screening test based on assessing glycated hemoglobin with the Bayer HealthCare A1cNow+ system. The results were analyzed according to ADA's criteria. The adopted cutoff HbA1c level indicating diabetes was ≥6.5%, whereas HbA1c levels of 5.7–6.4% marked a high risk of diabetes. A vast majority of subjects (82.4%) had normal HbA1c levels. High risk of diabetes was detected in 73 subjects (15.7%), while only 1.9% of subjects met diagnostic criteria for diabetes. Comparing the results demonstrated by the evaluated healthcare professionals with those shown as part of a multicenter trial in the Polish population, we can see significant differences.

As much as 32.2% of subjects participating in the multicenter study by Franek et al. conducted in the Polish population was at risk for diabetes, whereas metabolic disturbances (expressed with HbA1c levels) were present in 6.6% of the study population [1]. Our study showed no statistically significant differences between the male and female groups in terms of HbA1c levels. The study also demonstrated non-significant differences in HbA1c levels between the individual healthcare professional groups. However, consistently with physiology of the aging process and the increase in weight, HbA1c levels were shown to have a positive correlation with age (Table 6). Older people may be more overweight, have more insulin resistance, and – consequently – higher HbA1c levels. A similar situation can be observed in the case of HbA1c level and BMI correlation. Higher BMI values tend to be associated with higher insulin resistance and higher blood glycose levels. This means that increasing age and BMI values are accompanied by increasing values of glycated hemoglobin.

A pair of variables	n	r	p-value
HbA1c vs age	465	0.36	0
HbA1c vs BMI	465	0.30	0

*HbA1c: Glycated hemoglobin; BMI: Body mass Index; r: value of Spearman's rank correlation

Table 6: The influence of age and BMI on HbA1c in the group of medical workers.

Our independent research also addressed the overweight and obesity rates in the evaluated population of healthcare professionals. Higher-than-normal body weight has been progressively observed in the Polish population for the last several years. A similar tendency has been reported in other countries, especially highly developed ones. Reports based on nationwide Polish studies conducted as part of the following programs: NATPOL PLUS, WOBASZ, and "Household Food Consumption and Anthropometric Survey," demonstrated the rates of excessive weight in the Polish society. Excessive weight was reported in nearly 60% of adult men and nearly 50% of adult women. Overweight was more common in men (39–41%) than in women (28–29%). When it comes to obesity, the proportion of obese men was 16–21% and that of obese women was 19–22% [18]. The same classification of excessive body weight was used in our study. This was done to help compare the data collected from the healthcare personnel to that from the Polish population. The study conducted in healthcare personnel at SP CSK in Warsaw revealed 51.4% of subjects to have normal BMI values. Overweight was observed in 29.5% of subjects and obesity in 16.6%. Like in Polish nationwide studies, in our study BMI values in men were higher than those in women. The observed differences in BMI values between the individual professional groups were not statistically significant. Thus, we can say that our study ensured the evaluated, randomly selected groups to be homogeneous and comparable.

The results of our study indicated a need for active efforts to identify people with prediabetes or undiagnosed diabetes. The study also emphasized the problem of overweight and obesity (which requires instituting appropriate behavioral management), present also among healthcare professionals.

Conclusions

Most of the evaluated healthcare professionals demonstrated a good knowledge of the signs and symptoms of T2DM. Only 17.6% of respondents were unaware of their metabolic disturbances.

Slightly over half (51.4%) of the study group had normal BMI values, which does not give much credit to the preventive awareness in the evaluated healthcare group. One in three respondents (29.5%) were overweight and 16.6% of respondents were obese.

The study demonstrated a positive correlation between BMI values and HbA1c levels in the evaluated group of healthcare professionals (R=0.3), which was similar to that found in the general population. The study revealed no correlation between the presence of metabolic disturbances (expressed as glycated hemoglobin levels) and the type of medical profession.

Acknowledgment

Location of the Study and Ethics Approvals

The study was conducted at the Independent Public Central Clinical Hospital in Warsaw, Poland. The project was approved by Ethics and Research Review Committee of Medical University of Warsaw.

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