

# Prediabetes awareness among Southeastern European physicians

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Prediabetes, Primary prevention, Type 2 diabetes

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## ABSTRACT

**Aims/Introduction:** Prediabetes (PD) represents a transitional state where the glucose levels are higher than normal, but not enough for diabetes mellitus diagnosis. As there is a growing number of the population with PD, its early detection and treatment could prevent the development of diabetes mellitus and its complications. We aimed to assess the overall knowledge of PD among medical professionals of different varieties.

**Materials and Methods:** A questionnaire-based study addressing PD and type 2 diabetes mellitus knowledge among Southeastern European general practitioners, postgraduates, physicians and superior specialists was carried out.

**Results:** A total of 397 physicians completed the questionnaire. The total rate of correct answers from diabetologists, non-diabetologist internists, residents and general practitioners was 69, 56.1, 54 and 53%, respectively. Questions related to the PD definition achieved a total of 46.6% correct answers. Correct responses considering the numerical definition of impaired fasting glucose and impaired glucose tolerance were 46.3 and 46.8%, respectively. Younger physicians had better knowledge of numerical values regarding PD and type 2 diabetes mellitus criteria ( $P < 0.001$ ).

**Conclusions:** The present results show that overall knowledge of PD is poor among Southeastern European physicians, which necessitates adequate educational programs on PD in this region.

## INTRODUCTION

Type 2 diabetes mellitus has shown an intensive global spread and thus it could be observed as a pandemic disease. Prediabetes (PD) represents an intermediate state between normoglycemia and diabetes, where the glucose levels are higher than normal, but not enough to be diagnosed with diabetes mellitus. According to the recent American Diabetes Association (ADA) recommendations, PD includes: impaired glucose tolerance (IGT) with fasting plasma glucose levels of 5.6–6.9 mmol/L, impaired fasting glucose (IFG) with plasma glucose levels of 7.8–11.0 mmol/L 2-h postprandial, or both<sup>1</sup>. It is suggested that PD exists in more than one-third of the adult population in developed countries, and that it might contribute to the type 2 diabetes mellitus pandemic<sup>2,3</sup>. In addition, PD is characterized by oxidative stress and the progressive loss of pancreatic

$\beta$ -cells<sup>4</sup>, which gradually leads to persistent hyperglycemia. It is estimated that 25–50% of PD patients with glycosylated hemoglobin (HbA1c) between 6–6.5% (42.1–47.5 mmol/mol) will progress towards type 2 diabetes mellitus within a period of 5 years<sup>5,6</sup>. There is a different rate of progression towards type 2 diabetes mellitus among people with IFG or IGT; however, the combined abnormality of IFG plus IGT is associated with the highest relative risk for diabetes development<sup>7</sup>. In order to prevent or delay type 2 diabetes mellitus onset, there is an urgent need for appropriate treatment strategies. At the present time, lifestyle interventions or metformin therapy represent the PD treatment options<sup>1</sup>. The aim of present study was to assess the rate of understanding and basic knowledge of PD and type 2 diabetes mellitus among Southeastern European medical professionals of different varieties: general practitioners (GPs), non-endocrine specialists, endocrinologists and diabetologists, and residents from different fields.

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## METHODS

The present cross-sectional survey was carried out among 397 physicians from Southeastern European countries as follows: Croatia, Slovenia, Macedonia, Serbia, Montenegro, and Bosnia and Herzegovina. The questionnaire was composed of 11 questions regarding the diagnostic criteria of PD and type 2 diabetes mellitus. A total of 20 internationally recognized diabetes educators, endocrinologists, primary care physicians and researchers were invited to participate in the questionnaire development. During the first round, participants were asked to give their opinion on the most important questions to be included in the questionnaire. During the second round, participants were asked to give their opinion of each question as to whether it should be included in the final questionnaire, whether the question should be included if the phrasing was modified and, if they had to choose between two questions referring to the same domain, which one they would prefer. Finally, 11 multiple choice questions were developed by the researchers based on the domains that were answered as 'very important' by  $\geq 70\%$  of first- and second-round survey respondents. All questions were based on current ADA clinical guidelines for the care of persons with diabetes mellitus and PD<sup>1</sup>. We carried out a content validity index as suggested by Martuza in 1977 by using a content validity index for individual items; that is, a panel of content experts (5 of them) were asked to review the relevance of each question on a four-point Likert scale. Accordingly, as four of the five experts gave a score of 3 or 4, the validity was calculated to be content validity index = 0.80. Furthermore, the reliability was assessed by the correlation coefficient; that is, before the research was carried out, we carried out a pilot study including 12 randomly assigned physicians across the region giving participants the questionnaire at two separate points in time (8 months apart). Based on their answers, the relationship of scores was 0.75<sup>8</sup>. The questionnaire was given to 500 randomly selected physicians: GPs, endocrinologists and diabetologists, non-endocrine specialists, and residents from different fields. They were completed in clinical hospital centers, general hospitals, GP offices, and international and national congresses. Participants were asked to complete the survey in a quiet environment in 20 min under supervision, in order to avoid the possibility of Internet abuse or interpersonal consulting. The study was carried out in accordance with the Helsinki Declaration, and approved by ethical committee of Split University Medical School for clinical studies on human subjects (classification number: 003-08/17 - 03 / 0001; Reg. No.: 2181-198-03 -04-17 -OO25).

### Statistical analysis

Data distribution was assessed by the Shapiro–Wilk test. As the continuous (numerical) variables were not normally distributed, they were reported as the median, minimum and maximum, whereas the categorical variables were reported in absolute numbers and percentages. Differences between the groups based on the participants' specialization were examined using

the  $\chi^2$ -test. Correlations between age, work experience and the percentage of correct answers were determined by using Spearman's correlation coefficient. All the tests were two-sided. The level of statistical significance was chosen to be  $\leq 0.05$ . Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 20 for Windows (SPSS, Chicago, Illinois, USA).

## RESULTS

Out of 500 participants, 397 completed the questionnaire in its entirety. Their median age was 35 years (range 26–65 years) and work experience 15 years (range 0.10–40 years). There were 55.5% correct answers in total. The first three questions regarding the characteristics of PD were correctly answered by 46.6, 67.8 and 55.2% participants, respectively. Questions about the meaning of the IFG and IGT abbreviations were correctly answered by 43.3 and 66.0% participants, respectively. Normal values of fasting plasma glucose and postprandial glucose in a 2-h standard oral glucose tolerance test were accurately recognized in 66.0 and 53.9% of participants, respectively. The question regarding type 2 diabetes mellitus diagnosis criteria was answered correctly by 55.2% of participants. The question defining HbA1c values in PD was answered correctly by 54.1% of participants, whereas questions regarding criteria for IFG and IGT were correctly answered in total with 46.3 and 46.8% of participants, respectively. All the data are presented in Table 1. There was no significant correlation between age, work experience and percentage of correct answers ( $\rho = -0.228$ ,  $P = 0.077$  and  $\rho = -0.067$  and  $P = 0.182$ , respectively). Participants were further divided into the following groups: GPs, endocrinologists and diabetologists, non-endocrine specialists, and residents from different fields. Endocrinologists and diabetologists achieved the highest percentage of correct answers, as expected, whereas the lowest performance was observed among GPs (69.0 vs 53.0%,  $P < 0.001$ ). A detailed distribution of the correctly answered questionnaire among groups is given in Figure 1.

We found a statistically significant difference in favor of endocrinologists/diabetologists vs others (69.2 vs 53.6%,  $P < 0.044$ ) for the question regarding PD characteristics. Endocrinologists/diabetologists showed statistically significant better knowledge on IFG abbreviation compared with other groups (69.2 vs 39.9%,  $P < 0.001$ ), as well as the question regarding normal postprandial glucose in oral glucose tolerance test values (79.5 vs 50.8%,  $P < 0.01$ ), numerical values of fasting plasma glucose and postprandial glucose in the oral glucose tolerance test, and IFG and IGT diagnostic criteria (71.8 and 69.2% vs 50.8 and 44.7%, respectively,  $P < 0.01$ ).

No significant difference among groups was observed regarding questions referring to PD characteristics ( $P = 0.172$  and  $P = 0.677$ , respectively; Table 1), IGT abbreviation ( $P = 0.319$ ), fasting plasma glucose value in healthy people ( $P = 0.397$ ), and type 2 diabetes mellitus diagnostic criteria and numerical values of HbA1c in PD ( $P = 0.204$  and  $P = 0.273$ , respectively). An

**Table 1** | Overview of the total correct answers according to the question

Questions	General practitioners (n = 214) (%)	Non-endocrine specialists (n = 99) (%)	Endocrinologists & diabetologists (n = 39) (%)	Residents from different fields (n = 45) (%)	Total no. correct answers (n = 397) (%)
1. Define succinctly characteristics of prediabetes	45.3	40.4	56.4	57.8	46.6
2. Describe prediabetes features	64.9	72.7	69.2	68.9	67.8
3. Choose the correct answer that relates to prediabetes	51.9	56.6	69.2 <sup>†</sup>	55.6	55.2
4. The term IFG stands for?	37.6	50.5	69.2 <sup>†</sup>	28.9	43.3
5. The term IGT stands for?	62.1	71.7	74.4	64.4	66.0
6. Define the normal FPG level	64.5	73.7	74.4	55.5	66.0
7. Define the normal PG level at the second hour of OGTT or PPG	49.5	50.5	79.5 <sup>†</sup>	60.0	53.9
8. FPG and PPG levels as a criteria for DM diagnosis	55.6	48.5	66.7	57.8	55.2
9. HbA1c level as a criteria for PD diagnosis	50.5	63.6	59.0	46.7	54.1
10. FPG and PPG levels in OGTT as a criteria for IFG diagnosis	43.0	45.5	71.8 <sup>†</sup>	42.2	46.3
11. FPG and PPG levels in OGTT as a criteria for IGT diagnosis	42.5	44.4	69.2 <sup>†</sup>	55.5	46.8

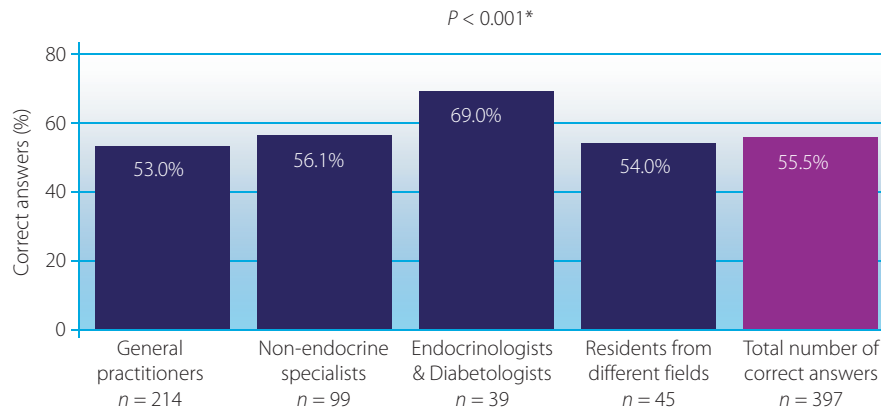
DM, diabetes mellitus; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; PD, prediabetes; PG, plasma glucose; PPG, postprandial glucose. <sup>†</sup>Endocrinologists/diabetologists vs all other groups differ significantly at a level of  $P < 0.05$ .

overview of the total correct answers according to profession and question are shown in Table 1.

Except for question number 1, where younger non-endocrine internists had 25% better results in comparison with all other groups, working experience did not affect the correctness of answers ( $P < 0.001$ ; Table 1).

## DISCUSSION

As a result of the pandemic proportions of type 2 diabetes mellitus incidence, as well as the enormous increase in treatment-related costs, it is clear that early identification and treatment of those individuals who are at high risk of disease development represent one of the major tasks of modern diabetology. Prediabetes could be considered as the subclinical phase of type 2 diabetes mellitus, and thus it is considered that treatment should start early on diagnosis. However, because of a lack of symptoms and PD awareness, it is often unrecognized in daily clinical practice. It is well known that the development of macrovascular complications in type 2 diabetes mellitus starts years before the diagnosis is established<sup>9–12</sup>, which emphasizes the importance of early PD recognition and treatment. The present results show that medical practitioners of different specialties generally have a lack of knowledge of PD, with just 55.5% of total correct answers. However, endocrinologists and diabetologists showed the highest level of knowledge of PD and the transition period to type 2 diabetes mellitus compared with GPs and non-endocrine specialists, as expected. This could be due to a lack of awareness or insufficient education on PD among other specialties. Non-endocrine specialists; for example, cardiologists, surgeons and neurologists who deal with diabetic complications, should possess essential knowledge of PD. Basavareddy *et al.*<sup>13</sup> carried out a cross-sectional study examining the knowledge and attitude among Indian physicians in regard to PD. Out of 150 participants, 122 completed questionnaires were received from GPs ( $n = 14$ ), postgraduates ( $n = 48$ ), physicians ( $n = 46$ ) and superior specialists, diabetologists ( $n = 14$ ). The physicians from Kolar and Bangalore showed better knowledge regarding the definition of PD, which is not in accordance with the present results. This might be due to the possibility of using different literature sources during the test study. A study by Weiland *et al.*<sup>14</sup>, which used the 72-item Illness Perception Questionnaire, showed that just 30% of emergency department patients and 72% of emergency department clinicians are familiar with the term of PD, which cannot be completely compared with the present study, as it was limited to physicians from emergency departments. According to current guidelines, early diagnosis, followed by education and relatively costless interventions (diet and physical activity counseling) could prevent the transition from PD to type 2 diabetes mellitus<sup>12,15,16</sup>. However, even the current ADA strategies for PD treatment are only superficially mentioned and no therapy is recommended<sup>17</sup>, whereas the prevalence of PD is expected to increase, and factors related to race, age and various characteristics related to sex are known to exist<sup>18</sup>. Given this, once



**Figure 1** | Overview of the total correct answers according to profession. \*Endocrinologists' and diabetologists' answers are statistically different from the other specialty groups at the significance level of  $P < 0.001$ .

detected, PD should be acknowledged with a treatment plan to prevent or to slow the transition to type 2 diabetes mellitus<sup>19</sup>. Considering all this, the present study results show an urgent need for raising awareness of PD, as well as active education of medical professionals and society in general at all levels. Based on the present study results, we can conclude that knowledge on PD pathophysiology, and the importance in early treatment initiation in everyday clinical practice among Southeastern European physicians is insufficient. This might be a result of inadequate presentation during undergraduate medical education. In addition, it is essential to highlight the inverse correlation between knowledge of PD characteristics with work experience. These results show that younger physicians have better knowledge regarding numerical values relating to the criteria of PD, which could suggest that senior physicians do not follow current PD and type 2 diabetes mellitus guidelines. Idiculla *et al.*<sup>20</sup> reported that diabetes guidelines *per se* appear to have little effect on increasing the information provided in GPs' referral letters. Also, diabetes guidelines had no effect in the frequency of screening for complications in patients with type 2 diabetes mellitus by GPs<sup>20</sup>. This might lead to the conclusion that besides guidelines, other types of information-providing resources are required to achieve optimal control for PD. Mainous *et al.*<sup>21</sup> showed that physicians who followed national guidelines for screening had a more positive attitude toward PD<sup>21</sup>. In Southeastern Europe, physicians rely on ADA and European Association for the Study of Diabetes guidelines for diabetes management<sup>1,22</sup>. Unfortunately, screening for type 2 diabetes mellitus has not been adopted as part of routine, particularly in Croatia<sup>23</sup>. Furthermore, the PD treatment recommendations do not represent an object of interest in Croatian guidelines for type 2 diabetes mellitus treatment<sup>24</sup>. As all of the countries that participated in this survey belong to low- or middle-income European countries, a type 2 diabetes mellitus prevention strategy would decrease the economic burden of the treatment of type 2 diabetes mellitus complications<sup>25,26</sup>.

The early identification of modifiable risk factors that make the greatest contribution to morbidity represents the key for a type 2 diabetes mellitus prevention strategy that could be achieved by community-based educational programs. This has been discussed thoroughly in the 'European Evidence-Based Guideline for the Prevention of Type 2 Diabetes'<sup>27</sup> dealing with the steps and strategies required to implement prevention, and the later one that Lindstrom *et al.*<sup>28</sup> outlined. Primarily, diabetologists and endocrinologists are the most competent to act in this direction, while GPs should be more involved. Prediabetes can often be reversed by weight loss, dietary changes and increased physical activity. The ADA, American Medical Association, and the Centers for Disease Control and Prevention have recently partnered with the Ad Council on the first national PD awareness campaign. The campaign encourages people to take a short online test to learn their risk for PD.

Although the present study had several limitations that should be pointed out, such as the small number of participants and cross-sectional design, we do believe that it highlighted the poor level of knowledge of PD and type 2 diabetes mellitus among physicians of different specialties and age. Early diagnosis of PD represents the key to preventing type 2 diabetes mellitus and its cardiovascular complications, and thus we consider that a great effort should be made in order to raise awareness of PD, its diagnosis and treatment guidelines among Southeastern European physicians. Therefore, there is an urgent need to implement current guidelines, as well as other methods in everyday clinical practice in order to raise awareness of PD.

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#### DISCLOSURE

The authors declare no conflict of interest.



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