Prediabetes awareness among Southeastern European physicians

Visnja Kocio1,2*, Slaven Kocio1, Mladen Knic1,2, Marin Petric1,3, Ana Marija Liberati4, Petra Simac1,3, Tatjana Milenkovic5, Vesna Capkun1, Dario Rahelic6, Kristina Blaslov7

1School of Medicine, University of Split, Departments of 2Endocrinology, Diabetes and Metabolic Disease, 3Rheumatology and Clinical Immunology, Clinical Hospital Center Split, Split, 4Department of Endocrinology, Diabetes and Metabolic Disease, Clinical Hospital “Sveti Duha”, Zagreb, Croatia, 5University St. Cyril and Methodius – University Clinic of Endocrinology, Skopje, Macedonia, 6Department of Endocrinology, Diabetes and Clinical Pharmacology, Clinical Hospital “Dubrava”, and 7University Hospital “Merkur”, Zagreb, Croatia

Keywords
Prediabetes, Primary prevention, Type 2 diabetes

*Correspondence
Visnja Kocio
Tel.: +385-91-516-22-00
Fax: +385-21-786-619
E-mail address: kokicvisnja@gmail.com

J Diabetes Investig 2018; 9: 544–548
doi: 10.1111/jdi.12740

ABSTRACT
Aims/Introduction: Prediabetes (PD) represents a transitional state where the glucose levels are higher than normal, but not enough to be diagnosed with 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. 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. In addition, PD is characterized by oxidative stress and the progressive loss of pancreatic β-cells, which gradually leads to persistent hyperglycemia. It is estimated that 25–50% of PD patients with glycated 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. 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. 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. The aim of present study was to access 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.
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 ≥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. 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. 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 χ²-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 ≤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 (p = 0.028, P = 0.077 and p = −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


**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\(^9\)–\(^12\), 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. Basavarreddy et al.\(^13\) 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.\(^14\), 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\(^12,15,16\). However, even the current ADA strategies for PD treatment are only superficially mentioned and no therapy is recommended\(^17\), 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\(^18\). Given this, once

| Questions | Endocrinologists & diabetologists \((n = 45)\) | General practitioners \((n = 214)\) | Non-endocrine specialists \((n = 99)\) | Residents from different fields \((n = 45)\) | Students \((n = 39)\) |
|-----------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------|
| 1. Define succinctly characteristics of prediabetes | 64.9 | 72.7 | 61.9 | 57.2 | 45.6 |
| 2. Describe prediabetes features | 64.9 | 72.7 | 61.9 | 57.2 | 45.6 |
| 3. Choose the correct answer that relates to prediabetes | 51.9 | 56.6 | 69.2 | 55.6 | 46.6 |
| 4. The term IFG stands for? | 37.6 | 50.5 | 69.2 | 55.6 | 46.6 |
| 5. The term IGT stands for? | 62.1 | 71.7 | 74.4 | 64.4 | 56.4 |
| 6. Define the normal FPG level | 64.5 | 73.7 | 74.4 | 64.4 | 56.4 |
| 7. Define the normal PG level at the second hour of OGTT or PPG | 49.5 | 50.5 | 79.5 | 60.0 | 53.9 |
| 8. FPG and PPG levels as a criteria for DM diagnosis | 55.6 | 48.5 | 66.7 | 59.0 | 46.7 |
| 9. HbA1c level as a criteria for PD diagnosis | 45.5 | 48.5 | 66.7 | 59.0 | 46.7 |
| 10. FPG and PPG levels in OGTT as a criteria for IFG diagnosis | 43.0 | 46.5 | 66.7 | 59.0 | 46.7 |
| 11. FPG and PPG levels in OGTT as a criteria for IGT diagnosis | 42.5 | 45.5 | 66.7 | 59.0 | 46.7 |

DM, diabetes mellitus; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; PD, pre-diabetes; PG, plasma glucose; PPG, postprandial glucose. Endocrinologists/diabetologists vs all other groups differ significantly at a level of \(P < 0.05\).
detected, PD should be acknowledged with a treatment plan to prevent or to slow the transition to type 2 diabetes mellitus. 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. 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. 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. showed that physicians who followed national guidelines for screening had a more positive attitude toward PD. In Southeastern Europe, physicians rely on ADA and European Association for the Study of Diabetes guidelines for diabetes management. Unfortunately, screening for type 2 diabetes mellitus has not been adopted as part of routine, particularly in Croatia. Furthermore, the PD treatment recommendations do not represent an object of interest in Croatian guidelines for type 2 diabetes mellitus treatment. 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.

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’ dealing with the steps and strategies required to implement prevention, and the later one that Lindstrom et al. 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.

ACKNOWLEDGMENTS
The authors thank all the study participants.

DISCLOSURE
The authors declare no conflict of interest.

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 $P < 0.001$. 

| Correct answers (%) | General practitioners $n = 214$ | Non-endocrine specialists $n = 99$ | Endocrinologists & Diabetologists $n = 39$ | Residents from different fields $n = 45$ | Total number of correct answers $n = 397$ |
|---------------------|-------------------------------|-------------------------------|----------------------------------|---------------------------------|----------------------------------|
| 0-20%               | 53.0%                         | 56.1%                         | 69.0%                            | 54.0%                           | 55.5%                            |

| $P < 0.001$ * |
REFERENCES

1. Professional practice committee for the standards of medical care in diabetes-2016. Diabetes Care 2016; 39(Suppl 1): S107–S108.

2. Bullard KM, Saydah SH, Imperatore G, et al. Secular changes in U.S. Prediabetes prevalence defined by hemoglobin A1C and fasting plasma glucose: National Health and Nutrition Examination Surveys, 1999–2010. Diabetes Care 2013; 36: 2286–2293.

3. Mainous AG 3rd, Tanner RJ, Baker R, et al. Prevalence of prediabetes in England from 2003 to 2011: population-based, cross-sectional study. BMJ Open 2014; 4: e005002.

4. Zaccardi F, Webb DR, Yates T, et al. Pathophysiology of type 1 and type 2 diabetes mellitus: a 90-year perspective. Postgrad Med J 1084; 2016: 63–69.

5. Standards of medical care in diabetes–2012. Diabetes Care 2012; 35 (Suppl 1): S11–S63.

6. Zhang X, Gregg EW, Williamson DF, et al. A1C level and future risk of diabetes: a systematic review. Diabetes Care 2010; 33: 1665–1673.

7. Gerstein HC, Santaguida P, Raina P, et al. Annual incidence and relative risk of diabetes in people with various categories of dysglycemia: a systematic overview and meta-analysis of prospective studies. Diabetes Res Clin Pract 2007; 78: 305–312.

8. Martuza RV. Applying Norm-referenced and criterion-referenced measurement in education. J Educ 1977; 160: 78–81.

9. Ramlo-Halsted BA, Edelman SV. The natural history of type 2 diabetes. Implications for clinical practice. Prim Care 1999; 26: 771–789.

10. Milman S, Crandall JP. Mechanisms of vascular complications in prediabetes. Med Clin North Am 2011; 95: 309–322.

11. Conkey BE. Banting lecture 2011: hyperinsulinemia: cause or consequence? Diabetes 2012; 61: 4–13.

12. Li G, Zhang P, Wang J, et al. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study. Lancet 2008; 371: 1783–1789.

13. Basavareddy A, Dass AS, Narayana S. Prediabetes awareness and practice among Indian doctors- A cross-sectional study. J Clin Diagn Res 2015; 9: FC01–FC03.

14. Weiland TJ, Nguyen M, Jelinek GA. Illness perception and knowledge with regard to prediabetes and type 2 diabetes: a pilot study of emergency department patients and staff. Eur J Emerg Med 2012; 19: 353–358.

15. Knowler WC, Fowler SE, Hamman RF, et al. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet 2009; 374: 1677–1686.

16. Tuomilehto J, Lindstrom J, Eriksson JG, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001; 344: 1343–1350.

17. Chamberlain JN, Rhinehart AS, Shafer CF Jr, et al. Diagnosis and Management of Diabetes: Synopsis of the 2016 American Diabetes Association Standards of Medical Care in Diabetes. Ann Intern Med 2016; 164: 542–552.

18. Rhee SY, Woo JT. The prediabetic period: review of clinical aspects. Diabetes Metab J 2011; 35: 107–116.

19. Dunkley AJ, Bodicoat DH, Greaves CJ, et al. Diabetes prevention in the real world: effectiveness of pragmatic lifestyle interventions for the prevention of type 2 diabetes and of the impact of adherence to guideline recommendations: a systematic review and meta-analysis. Diabetes Care 2014; 37: 922–933.

20. Idiculla JM, Perros P, Frier BM. Do diabetes guidelines influence the content of referral letters by general practitioners to a diabetes specialist clinic? Health Bull (Edinb) 2000; 58: 322–327.

21. Mainous AG 3rd, Tanner RJ, Scuderi CB, et al. Prediabetes screening and treatment in diabetes prevention: the impact of physician attitudes. J Am Board Fam Med 2016; 29: 663–671.

22. Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of hyperglycaemia in type 2 diabetes, 2015: a patient-centred approach. Update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. Diabetologia 2015; 58: 429–442.

23. Vrca Botica M, Carkaxhiu L, Kern J, et al. How to improve opportunistic screening by using EMRs and other data. The prevalence of undetected diabetes mellitus in target population in Croatia. Pub Health 2017; 145: 30–38.

24. Rahelic D, Altabas V, Bakula M, et al. Croatian guidelines for the pharmacotherapy of type 2 diabetes. Lijec Vjesn 2016; 138: 1–21 (Croatian).

25. Dall TM, Yang W, Halder P, et al. The economic burden of elevated blood glucose levels in 2012: diagnosed and undiagnosed diabetes, gestational diabetes mellitus, and prediabetes. Diabetes Care 2014; 37: 3172–3179.

26. Tao X, Li J, Zhu X, et al. Association between socioeconomic status and metabolic control and diabetes complications: a cross-sectional nationwide study in Chinese adults with type 2 diabetes mellitus. Cardiovasc Diabetol 2016; 15: 61.

27. Paulweber B, Valensi P, Lindstrom J, et al. A European evidence-based guideline for the prevention of type 2 diabetes. Horm Metab Res 2010; 42: 3–36.

28. Lindstrom J, Neumann A, Sheppard KE, et al. Take action to prevent diabetes—the IMAGE toolkit for the prevention of type 2 diabetes in Europe. Horm Metab Res 2010; 42: 37–55.