Comparison of “burden of disease” in elderly and non-elderly patients with prediabetes: A cross-sectional study

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ABSTRACT

OBJECTIVE: There are a lot of studies comparing elderly and adult patients with diabetes but not prediabetes systematically. We aimed to compare the discrepancies of clinical status and burden of disease in elderly (≥60 years old) versus non-elderly (18–59 years old) adult prediabetics. This cross-sectional study is the first paper that brings this deficiency to the literature.

METHODS: A total of 126 prediabetic patients were included in the study and were compared as two groups; elderly (n=32) and non-elderly (n=94). Fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c) levels, body mass index (BMI), the homeostasis model assessment of insulin resistance (HOMA-IR), Health-Related Quality of Life (HRQoL) using the Short Form-36 (SF-36) questionnaire, disability using the Health Assessment Questionnaire (HAQ) were evaluated.

RESULTS: Gender, BMI, the presence of obesity, the ratio of HOMA-IR, FPG and plasma glucose in 2nd hour OGTT were similar in non-elderly patients with prediabetes compared to elderly ones. But HbA1c levels were higher in the elderly subjects in our study. According to the SF-36 questionnaire and HAQ score; there were no significant differences between groups. The median total HAQ scores were 0.125 (non-elderly) and 0.250 (elderly) for groups and there was no significant difference (p=0.099).

CONCLUSION: In the similar gender and BMI groups; prediabetes in the elderly gives different outcomes according to HbA1c. Since SF-36 questionnaire and HAQ scores were not statistically different in both prediabetic groups, the burden of disease is thought to be basically due to the presence of the disease rather than aging.

Keywords: Burden of disease; disability; elderly; prediabetes; quality of life.

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Prediabetes contains impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) which consists of serum glucose levels are higher than normal but below the values of diabetes. According to the American Diabetes Association (ADA), IGT is described as a 2-hour plasma glucose range of 140 to 199 mg/dL, and IFG as a fasting plasma glucose range of 100 to 125 mg/dL in the 75-gram oral glucose tolerance test (OGTT). Prediabetes can also be characterized as glycated hemoglobin (HbA1c) value of 5.7% to 6.4% [1, 2].

Prediabetes is speedily becoming an important worldwide health theme. In adults, the prevalence of prediabetes is 38% in the USA [3], 35.7% in China [4] and 30.8% in Turkey [5]. Prediabetes is a risk factor for many systemic disorders such as neuropathic, renal diseases, cognitive problems like type 2 diabetes mellitus (T2DM).
As a result of prediabetes, complications arising are known to negatively impact a lot of conditions of the patient’s life including the Health-Related Quality of Life (HRQoL) [7].

The geriatric population is increasing with the aging world. As the reflection of many diseases in the geriatric population is different, our approach to diseases should be different. In the elderly population, T2DM is one of the major cause of disease burden [8]. This has been a noteworthy problem since the life expectancy has been increasing recently in diabetic patients [9]. Elderly diabetics have more difficulties in standing to their usual social relationships [10]. HRQoL is usually worse in elderly diabetic patients when compared to younger diabetics [11].

Hyperglycaemia is such an important inconvenience that it affects not only the internal organs but also the skin. Diabetes is a disease that causes even skin lesions and affects the entire body. [12]. Whereas one of the aim of the treatment of non-elderly diabetics is to prevent the development of microvasculary and macrovasculary complications, one of the significant aim in the treatment of elderly ones is to improve QoL. While there are a lot of studies comparing elderly and adult diabetics but not prediabetes systematically [8, 10, 11]. It is not known whether adding prediabetes to the effects of old age on quality of life and disability will create a synergy. We aimed in this study to present the discrepancies of clinical status and burden of disease in elderly versus non-elderly adult prediabetics.

**MATERIALS AND METHODS**

**Participants**

People, over the 18 years old, who were admitted to a tertiary hospital’s internal medicine outpatient clinic between 1 June 2018 and 31 August 2018 for routine health control and who agreed to participate to the study were recruited. The patient’s written informed consent to publish the clinical informations and materials was obtained. This study was performed in accordance with the Declaration of Helsinki and Good Clinical Practice. Informed consent needed for the study is received from Erciyes University Local Ethical Committee (Decision no: 2019/141).

Patients with newly diagnosed prediabetes according to ADA were recruited to the study, consecutively [2]. A total of 126 prediabetic patients were enrolled and compared as two groups; elderly (18–59 years old) and non-elderly (≥60 years old).

**Interventions**

Participants’ age, gender were recorded. The number of comorbid conditions (hypertension, muscle-joint-bone disease, gastrointestinal diseases, heart disease, hyperlipidemia, respiratory system diseases, depression/anxiety disorders, and other rare chronic diseases), drugs taken daily (suitable for comorbidity) and operations were also recorded. Their height and weight were measured. Body mass index (BMI) was calculated and then categorized as normal (BMI <30 kg/m²), and obese (BMI: 30 kg/m² and above) [13].

Plasma glucose values at 0th and 2nd hours were conducted by oral glucose tolerance test (OGTT), and glycated hemoglobin (HbA1c) levels were measured for all participants. Prediabetes was defined as 0-hour plasma glucose value (OGTT-0th) of 100–125 mg/dL (impaired fasting glucose) and/or 2-hour plasma glucose value (OGTT-2nd) of 140 mg/dL to 199 mg/dL (impaired glucose tolerance). HbA1c value of 5.7% to 6.4% was also considered to be prediabetes [2]. A fasting venous blood sample (FBS) was collected after an overnight fast of at least 12 hours for biochemical investigations and samples were processed at the hospital laboratory on the same day. Glucose levels were estimated using a Roche Cobas 8000 immunoassay analyzer (Roche Diagnostics, USA). The level of HbA1c were estimated using a Adams A1c HA-8180V automatic analyzer (Arkray Diagnostics, USA). All assays were performed with specific kits and calibrators supplied by the manufacturers.

**Insulin Resistance (IR)**

12-hour FBSs were obtained for fasting plasma insulin (FPI) and fasting plasma glucose (FPG) determinations in order to calculate the homeostasis model assessment of insulin resistance (HOMA-IR). It was calculated by the formula [14]:

\[
\text{HOMA-IR} = \frac{\text{FPI} (\text{mU/L}) \times \text{FPG} (\text{mmol/L})}{22.5}
\]

If the result is ≥2.5, it means there is an insulin resistance. The higher the score, the greater the insulin resistance is measured.

**Health-Related Quality of Life (HRQoL) Using the SF-36 Questionnaire**

We used Short Form-36 (SF-36) that is a valid, and re-
liable questionnaire to assess both physical and mental components of HRQoL [15, 16]. SF-36 contains 36 items associated to 8 dimensions: physical functioning for the limitation in performing all physical activities, role-physical for problems with work or other daily activities, bodily pain, general health, vitality, social functioning, role-emotional, and mental health [15]. SF-36 is also a valid and reliable questionnaire in Turkish people [17].

Disability Using the HAQ

The another dependent variable in this study was disability. To assess the disability, the Stanford Health Assessment Questionnaire-20 (HAQ) was used [18]. Qualification of HAQ were also proven [19, 20]. HAQ is a reliable, valid, sensitive questionnaire in both general, and patient populations [21]. The HAQ assesses disability in eight fields (dressing and grooming, rising, reach, hygiene, eating, walking, grip and activity). In each section, there are 2 or 3 questions. Scoring within each question is from 0 (without any difficulty) to 3 (unable to do). For each section, the score given to that section is the worst score within the section, i.e., if one question is scored 1 and another 2, then the score for the section is 3. Also, if an aide or device is used or if help is required from another individual, then the minimum score for that section is 2. The mean score of the eight sections is disability index (DI), ranges from 0.00 to 3.00, that the higher the score, the greater the disability is determined. In this study patients with a DI lower than 0.50 were considered not disabled, a DI from 0.50 to 1.00 were considered as mild disability while a DI of 1.00 or higher was regarded as severe disability [22]. HAQ-DI is also a valid and reliable questionnaire in Turkish people [23].

SF-36 and HAQ questionnaire was full-filled by assistance of a rheumatologist (K.E.) who was blinded the patients’ clinical data, if required.

Statistical Analysis

A power analysis program was used to calculate the post hoc power analysis. It was done considering HAQ as a primary outcome measure. It was determined that the study was designed to have 78% power to detect in HAQ scoring between both groups. Statistical analyses were performed using the SPSS software version 22.0 (IBM Corp., Armonk, NY, USA). Parametric variables were presented as means and standard deviations, non-parametric variables were presented as medians and interquartile ranges (25th–75th percentiles). Shapiro-Wilks test and histograms analyses were used to determine whether continuous variables were normally distributed. Two independent groups of parametric variables were compared using Student t test. For non-parametric variables Mann Whitney U test was administered. Number of cases and percentages were used for categorical variables. Categorical data were analyzed by Chi-square or Fisher’s exact test, where appropriate. A P value of <0.05 was considered to indicate statistically significant differences.

RESULTS

Newly diagnosed 126 prediabetics, admitted our internal medicine outpatient clinic, were recruited consecutively. 32 of them (25%) were elderly and the others (%75) were non-elderly. Gender, height, weight, BMI, the presence of obesity, the ratio of HOMA-IR, fasting glucose level (0-h OGTT) and glucose level in 2-h OGTT were similar in elderly patients with prediabetes compared to non-elderly ones. But HbA1c levels were higher in the elderly subjects. Whereas the number of comorbid conditions and drugs taken daily of patients were higher in the elderly group, the number of operations were similar in both groups. Comparison of clinical data of elderly and non-elderly patients was mentioned in Table 1.

All dimensions and total scores of SF-36 were similar between elderly and non-elderly patients. HAQ-DI scores were a little higher in elderly patients than non-elderly ones but this difference was not statistically significant. All of the SF-36 and HAQ-DI scores were mentioned in Table 2.

DISCUSSION

In this study, prediabetics under age 60 and elderly ones were compared. To the best of our knowledge HRQoL and DI in elderly and non-elderly prediabetics were conducted and compared firstly in the literature. Prediabetes associated laboratory findings were similar between groups. The number of comorbid conditions and drugs were statistically significantly higher in the elderly. Comparable QoL levels were found. DI scores were worse in elderly group than non-elderly group, but not statistically significant.

There is no consensus on the change of BMI with age in prediabetic patients. While the studies by Rabi-
jewski et al. [24] (with 196 participants) and Wu et al. [25] (with 1347 participants) showed that BMI values increased with the age, there were no significant differences between elderly and non-elderly patients in studies of Yan et al. [26] (with 2735 participants) and Chen et al. [27] (with 1374 participants). Elderly and non elderly prediabetic patients had similar BMI in our study, too.

In many studies, glucose in FP (0-h OGTT) and 2nd-

**TABLE 1. Comparison of elderly and non-elderly prediabetic patients’ clinical data***

<table>
<thead>
<tr>
<th></th>
<th>Non-elderly (n=94)</th>
<th>Elderly (n=32)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, female/male (%)</td>
<td>71/23 (75.6/24.4)</td>
<td>22/10 (68.8/31.2)</td>
<td>0.489</td>
</tr>
<tr>
<td>Age, years, median (per 25–75)</td>
<td>48 (42–52)</td>
<td>65 (62–69)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight (kg), mean±SD</td>
<td>88.28±18.93</td>
<td>87.39±13.75</td>
<td>0.808</td>
</tr>
<tr>
<td>Height (meters), mean± SD</td>
<td>1.62±0.80</td>
<td>1.60±0.07</td>
<td>0.206</td>
</tr>
<tr>
<td>BMI (kg/m²), mean±SD</td>
<td>34.02±7.94</td>
<td>34.54±6.19</td>
<td>0.738</td>
</tr>
<tr>
<td>Glucose in 0-h OGTT (mg/dl), mean±SD</td>
<td>104.19±8.41</td>
<td>104.09±9.16</td>
<td>0.956</td>
</tr>
<tr>
<td>Glucose in 2-h OGTT (mg/dl), mean±SD</td>
<td>130.50±32.48</td>
<td>133.36±33.70</td>
<td>0.669</td>
</tr>
<tr>
<td>HbA1c, mean±SD</td>
<td>5.87±0.34</td>
<td>6.05±0.27</td>
<td>0.006</td>
</tr>
<tr>
<td>Obesity (obese/non-obese), (%)</td>
<td>64/30 (68.1/31.9)</td>
<td>26/6 (81.3/18.7)</td>
<td>0.180</td>
</tr>
<tr>
<td>HOMA-IR, median (per 25–75)</td>
<td>2.59 (1.65–3.94)</td>
<td>2.39 (1.51–4.52)</td>
<td>0.340</td>
</tr>
<tr>
<td>The number of comorbid conditions, (per 25–75)</td>
<td>0 (0–1)</td>
<td>2 (1–3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>The number of drugs taken daily, (per 25–75)</td>
<td>0 (0–1)</td>
<td>2.5 (1.25–4.75)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>The number of operations, (per 25–75)</td>
<td>1 (0–2)</td>
<td>1 (1–3)</td>
<td>0.051</td>
</tr>
</tbody>
</table>

SD: Standard deviation; BMI: Body mass index; OGTT: Oral glucose tolerance test; HbA1c: Glycated hemoglobin; HOMA-IR: The homeostasis model assessment of insulin resistance. *: Data are presented as a mean±standard deviation of the mean, a median with (per 25–75), or number (percentage), where appropriate (p<0.05 considered statistically significant).

**TABLE 2. Medians of the scales in the SF-36 and HAQ in prediabetics***

<table>
<thead>
<tr>
<th></th>
<th>Non-elderly (n=94)</th>
<th>Elderly (n=32)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-36 dimensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical functioning</td>
<td>80 (51.25–100)</td>
<td>72.5 (45–90)</td>
<td>0.136</td>
</tr>
<tr>
<td>Role-physical</td>
<td>12.5 (0–100)</td>
<td>0 (0–100)</td>
<td>0.472</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>57.5 (45–77.5)</td>
<td>55 (27.25–77.5)</td>
<td>0.363</td>
</tr>
<tr>
<td>Social functioning</td>
<td>62.5 (50–87.5)</td>
<td>62.5 (40.63–85)</td>
<td>0.678</td>
</tr>
<tr>
<td>Mental health</td>
<td>60 (44–72)</td>
<td>64 (52–71)</td>
<td>0.645</td>
</tr>
<tr>
<td>Role-emotional</td>
<td>33.3 (0–100)</td>
<td>33.33 (0–100)</td>
<td>0.775</td>
</tr>
<tr>
<td>Vitality</td>
<td>60 (45–75)</td>
<td>60 (46.25–80)</td>
<td>0.999</td>
</tr>
<tr>
<td>General health</td>
<td>55 (30–80)</td>
<td>55 (40–75)</td>
<td>0.952</td>
</tr>
<tr>
<td>SF-36/PCS</td>
<td>57.19 (35–84.84)</td>
<td>52.19 (30.16–79.84)</td>
<td>0.350</td>
</tr>
<tr>
<td>SF-36/MCS</td>
<td>55.02 (36.81–79.81)</td>
<td>63.96 (35.66–76.49)</td>
<td>0.864</td>
</tr>
<tr>
<td>SF-36/TS</td>
<td>52.81 (37.51–81.11)</td>
<td>59 (32.50–79.19)</td>
<td>0.594</td>
</tr>
<tr>
<td>HAQ</td>
<td>0.125 (0–0.375)</td>
<td>0.250 (0–0.813)</td>
<td>0.099</td>
</tr>
</tbody>
</table>

SF-36: Short Form-36; SF-36/PCS: Short Form-36 physical component score; SF-36/MCS: Short Form-36 mental component score; SF-36/TS: Short Form-36 total score; HAQ: Health Assessment Questionnaire. *: Data are presented as a median (per 25–75); SF-36 dimension scores range from 0 to 100, where a higher score reflects better functioning. P<0.05 considered statistically significant.
h OGTT were statistically significantly higher in elderly prediabetic patients than young and middle-aged groups [24–26, 28]. In our study, FPG were similar between two age groups. However, glucose in 2-h OGTT were higher in elderly prediabetics, but not statistically significant. In the process leading to diabetes, while first-time postprandial blood glucose (or 2-h OGTT) increases, we think that this will be more obvious with advancing age. Rabijewski et al. argued that older patients with prediabetes had a worse quality of life than middle-aged ones, with a small degree of imbalance in glucose [28]. Considering this direction for our study, it may be said that the similarity between the groups in terms of quality of life may related to similar plasma glucose levels.

Whereas glucose levels of groups were similar, HbA1c levels were statistically significantly higher in the elderly. In many studies, it was shown that HbA1c values associated with a limited sensitivity in the elderly population. And HbA1c is not suitable for diagnosing diabetes in this population [29–31]. The National Health and Nutrition Examination Survey (NHANES) data showed that if only HbA1c is used to diagnose DM in the elderly, the frequency of DM may be higher than it is [32]. Pani et al. [33] showed that HbA1c levels are positively associated with age in non-diabetic populations, even after the exclusion of participants with IGT, and suggested that an age specific diagnostic criterion of HbA1c is needed [26]. High HbA1c values in elderly prediabetics that we found in our study suggest that there is a need for age-adjusted HbA1c values in PD diagnosis.

A large observational prospective study using the data of 4566 patients (normal, prediabetes and T2DM) showed that aging is associated with increased HOMA-IR score in an elderly Chinese population [34]. In another study with 1374 patients by Chen et al., elderly (≥60 years) prediabetic patients had higher HOMA-IR scores than young (<40) prediabetic patients [27]. Contrary to the literature, in our study, there were no statistically differences in insulin resistance (the ratio of HOMA-IR) between the elderly and non-elderly participants. The fact that FPG, glucose in 2h OGTT and BMI values were not statistically different between groups may have caused this situation.

The gender, BMI and laboratory results of the two groups were also comparable. The outcome of this clinical results provided us with the opportunity to compare the HRQoL and DI on similar terms between the groups. In many studies it is reported that poorer QoL in diabetic patients; however, data regarding QoL in prediabetics is scarce. In a study of 176 prediabetic patients by Rabijewski, mental health, vitality, and general health were significantly lower in prediabetics than the control group. Rabijewski et al. made up their study exclusively from men and studied them in two groups, middle-aged men (40–60 years) and elderly (60–80 years). The mean scores for mental health, vitality, general health, and physical functioning were significantly higher in case of middle-aged prediabetic men. Whereas the middle-aged group presented with higher SF-36 physical component scores, the SF-36 mental component scores were not different [28]. Our study was a more comprehensive study involving both genders and all ages (18–80 years). No significant difference was found between elderly and non-elderly patients according to the SF-36 questionnaire results. We would like to re-emphasize that these outcomes were obtained in similar groups, especially in terms of gender, height, weight, BMI, the presence of obesity, the ratio of HOMA-IR, FPG and glucose levels in 2h OGTT. These findings show that the decrease in quality of life is mainly related to prediabetes rather than old age in prediabetic patients. It is known that the quality of life decreases with increasing age [35–37]. Although the number of comorbid conditions, drugs and operations were higher in the elderly, SF-36 components were found similar in our study. Therefore, prediabetics seems to affect the quality of life more than factors such as age and comorbidity.

There are a few studies on health assessment in elderly diabetics. In a controlled survey study of 116 diabetic patients who are African Americans aged 70 years and over, the elderly had worse DI scores (using the HAQ) than the control group. They reported that disability is related with lesser additive from the number of drugs, medical problems, and hyperglycaemia due to multivariable analyses [38]. There are several studies evaluating elderly patients with diabetic foot ulcers, and a lower HAQ score than those without diabetic foot ulcers [35–39]. In our study, HAQ scores were higher in elderly prediabetics, but not statistically significant. The number of comorbid conditions and drugs taken daily, which were higher in the elderly, can have an effect on the HAQ scores. Differences could have become significant if our study had been conducted with more participants.

There are some limitations of our study: Firstly; conditions related to the occupational and social life of the patients may affect the scales. Secondly; since it is the first study in the literature, the number of participants is
limited. This may have affected the results. However, this may become a reference article for larger future studies.

In conclusion; except HbA1c, diabetes related laboratory parameters were similar between elderly and non-elderly prediabetics. HRQoL was similar between two age groups, and DI was slightly higher in elderly prediabetics than non-elderly ones but not statistically significant. In prediabetic patients, the burden of disease is thought to be basically due to the presence of the prediabetes rather than aging. This study, which we first gained in order to raise awareness in the literature of prediabetics, should be elaborated with further studies.

Ethics Committee Approval: The Erciyes University Clinical Research Ethics Committee granted approval for this study (Decision no: 2019/141).

Conflict of Interest: No conflict of interest was declared by the authors.

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Authorship Contributions: Concept – UST, KE; Supervision – KE; Materials – UST; Data collection and/or processing – UST, KE; Analysis and/or interpretation – UST, KE; Writing – UST; Critical review – KE.

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