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Anthropomorphic and Body Composition Differences in Prediabetes and Normal Subjects

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Abstract

Purpose: Prediabetes refers to a condition where the level of fasting blood sugar reaches 100- 125 mg/dl. The prediabetes pervasiveness is growing throughout the world. The main objective of the present research is the exploration of the body composition and anthropomorphic differences among prediabetes and normal people for finding the plans for scanning prediabetes and the impact of exercise on it. **Method:** The present descriptive cross-sectional research conducted on 251 people. The signed informed consents and information of the education, age, exercise etc. gathered. Then, blood glucose tested, and 133 and 118 participants respectively had been chosen for the prediabetes and normal groups. Digital scales, wall stadiometer, tape measure and body composition monitor had been employed to measure anthropomorphic and body composition indices. **Results:** Total pervasiveness of prediabetes was 52.98% that accounted for 41.03% of the male and 11.95% of the female. Any significant differences didn't found in the education level, exercise and physical activity between two groups (p>0.05). However, there was a significant difference in the age just in the male group (p=0.043). It found that the prediabetic participants experience visceral fat, BMI, WC, and WHR higher than the normal participants (p=0.037, p=0.010, p=0.000, and p=0.002, respectively) just in the female group. **Conclusions:** It has been concluded that anthropomorphic and body composition have differences between normal and prediabetes participants; therefore, they may be used as the screening programs. Moreover, it has been suggested that prediabetes can be prevented by controlling anthropometric and body composition indices by exercise.

Keywords: Anthropomorphic indices, Body composition, Diabetes, Employee, Exercise

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INTRODUCTION

It is well known that prediabetes is the Fasting Blood Sugar (FBS) that is above the normal range (100 to 125 mg/dl) but not high enough to be diagnosed as the diabetes mellitus (DM) (Tuomilehto et al., 2001). In fact, prediabetes occurs as the fasting glucose elevates and glucose tolerance becomes abnormal or both of these happen (American Diabetes Association, 2004). Actually, prediabetes is quickly growing throughout the world so that the current estimations indicate that 340 million people suffer from prediabetes (Roglic & Unwin, 2010) and it is likely to influence above 400,000,000 individuals in 2030 (Tabák, Herder, Rathmann, Brunner, & Kivimäki, 2012). According to a study conducted in Tehran in 2015, the results showed that the incidence of diabetes and pre-diabetes were 1% and 4% of the community in the year (Azizi & Hadaegh, 2015). According to the studies, uncontrolled level of the blood glucose in the participants with prediabetes may cause the type 2 DM (T2DM) and the respective consequences (Cowie et al., 2009). In addition, current estimations suggested that 34% of people suffering from prediabetes can progress T2DM during 7.5 years (Ackermann, Cheng, Williamson, & Gregg, 2011). Nevertheless, this condition frequently is underdetected and would be asymptomatic that can increase additional hazards of diabetes and the respective side effects (Unwin, Shaw, Zimmet, & Alberti, 2002). Thus, initial diagnoses of the prediabetes using anthropometric and body composition indices would reduce or delay the DM development and the respective consequences. Diabetes related diseases include retinopathy, cardiomyopathy, neuropathy and etc. (Bonora & DeFronzo, 2018; Deshpande, Harris-Hayes, & Schootman, 2008; Morgan et al., 2000).

Based on the results, overweight and obesity have been commonly described as the body mass index (BMI) $\geq$25 kg/m^2 and $\geq$30 kg/m^2, respectively. Researchers showed that the obesity and overweight pervasiveness in developing countries is elevating significantly as a result of the alterations in the life style and urbanization, absence of the physical activities, and the most importantly increase of lengthy working hours. In fact, obesity and overweight have been regarded as the main variable risks for T2DM and reflect a key public health issue for individual quality of life and costs to the healthcare systems (Aballay, Eynard, Díaz, Navarro, & Muñoz, 2013). However, recent investigations have demonstrated that there is a correlation between obesity and prediabetes (Abtahi et al., 2010; Hosler, 2009). Additionally, the overestimated systemic inflammation in responding to the excess visceral adipose tissues has been suggested as the major mediating factor in the pancreas functional failure that contributes importantly to the T2DM (F.-S. Yang et al., 2013). Moreover, epidemiological investigations showed the occurrence of the risky consequences in the initial phase of diabetes. Hence, prevention of the obesity and overweight may decline the risks of prediabetes and diminish the costs, necessary health resources, and side effects of diabetes, and thus it may ameliorate the life quality (Wang et al., 2017).

Additionally, body composition and anthropometric indicators like body fat, muscle mass, visceral fat, BMI, waist circumference (WC), and waist-hip ratio (WHR) have been considered as prominent instruments for assessing the obesity and overweight as the risk parameters of the prediabetes because of simple accessibility, cost-effectiveness, and non-invasiveness. Notably, measurement of each anthropometric index would be required since all factors would have limitations to diagnose prediabetes. For instance, BMI indicated a quick information of the fat percentage and muscle mass indirectly; however, it did not provide any information about the fat distribution while WC and WHR had higher reliable indicators for detecting the fat distribution, particularly abdominal region. With regard to the significance of the anthropometric indicators, this study aimed at investigating anthropomorphic and body composition differences in the prediabetes and normal participants for identifying the prediabetic participants.

METHOD

Inclusion and exclusion participants

The present descriptive, single center and cross-sectional study has been conducted on 251 subjects in an age range between 25 to 70 years in Tehran. The statistical population consisted of 700 employees of the Energy Industries Engineering and Design (EIED) Company. According to Cochran formula, the sample size was obtained 251 subjects. In addition, each participant completed the signed informed consent. It should be noted that information such as age, educational level, exercise and physical, life style, socio-demographics, family history of the type 2 diabetes mellitus in the first-degree relatives, job, smoking, medicine consumption, medical history, and diseases history have been explored in the subjects. Ultimately, when the blood glucose had been tested, 133 participants have been chosen for the prediabetes group and 118 of them have been allocated to the normal group (Baltadjiev & Baltadjiev, 2011). Also, researcher ensured that participants' identity and what they said or did during research was maintained confidential. The research protocol was approved by the Health Committee of the Energy Industries Engineering and Design (Iran).

Instruments and Measurements

Blood Sugar

Based on the American Diabetes Association (ADA) standards, the healthy people or prediabetic patients have been identified by FBS (Fasting Blood Sugar) measurement using Hexokinase method on a close system (COBAS INTEGRA®400plus analyzer, Roche kit). Prediabetic participants have been defined as those with FBS≥100 mg/dL and <126 mg/dL. However, people having normal range of the level of blood glucose have been chosen as the control group (FBS less than100 mg/dL) (Kahn, 2003).

Exercise and physical activity assessment

In this study, Baekce Physical Activity Questionnaire (BQ) was used to measure exercise and physical activity. The questionnaire contains 16 questions based on the Likert scoring method that measures the amount of physical activity during work, exercise and leisure time. Job section questions are about the type of job, the intensity of work activity, and the situation of person at work. The questions in the exercise section are for people who do regular physical activity and determine the duration, intensity, and type of activity. In the leisure section, questions are asked about activities such as cycling, hiking, and watching television that one does in their leisure time (Okosun IS, Choi S, Matamoros T, Dever GE, 2001).

Anthropomorphic and body composition assessment

As mentioned earlier, digital scales (Omron, BF511) to the near 0.1 kg has been used to measure the body weight of the subjects who had light clothing and no shoes. In addition, a wall stadiometer has been utilized to measure the height to the adjacent 0.cm with the participants' heads in the Frankfort plane with no shoes. Then, the BMI has been computed as the weight divided by the square of height (kg/m^2).

Moreover, WC has been gauged at the level mid-point between the lowest of the upper border of the iliac crest and rib cage through a tape measure. Furthermore, the hip circumference has been measured surrounding the widest portion of the buttocks through a tape measure. Finally, WHR has been achieved via division of the waist circumference by the hip circumference.

It should be mentioned that bio-electrical impedance analysis (Omron; BF511; Korea) has been used to evaluate the body composition of each participant. The defined variables have been the visceral fat, body fat, and muscle mass.

Statistical Analysis

SPSS 22 has been used to do data analysis. First, the normality of the data was tested by Kolmogorov–Smirnov test. In addition, the Pearson correlation coefficient and paired T-test (2-tailed) has been employed for relationship between variables and comparing the differences between groups respectively. Notably, p-value <0.05 has been regarded statistically signiifcant□

RESULTS

Total numbers of the participants of this research have been 251 cases. Participants included 167 (66.54%) male and 84 (33.46) female. Moreover, the mean age of the females and males respectively has been 39.95 and 42.7 years. From among them, 133 have been prediabetic and 118 have been the control group with normal level of blood glucose. It has been found that the educational level between the prediabetic and normal participants in the two male and female do not have statistically significant differences (p=0.495, p=0.380 respectively). Moreover, we did not observe any statistically significant differences in the age between the prediabetic and normal participants just in the female group. Even though the age showed statistically significant differences between both normal and prediabetic participants in the male group (p=0.043) (Table 1), the prediabetic male participants have been approximately 2.5 years older than the normoglycemic male.

Table 1: Descriptive characteristics of normal and prediabetic participants (N=251)

Variables	Male			Female		
	Prediabet N=(103, 41.03%)	**Normal** N=(64, 25.49%)	**P**	**Prediabet** N=(30, 11.95%)	**Normal** N=(54, 21.51%)	**P**
Age	41.875	39.424	0.043*	40.567	39.352	0.335
Education	16.214	15.891	0.495	16.53	16.907	0.380

* Correlation is significant at the 0.05 level (2-tailed).

As seen in Table 2, exercise index and physical activity showed that was not significant different between prediabetic and normal groups (p=0.886, p=0.209 respectively).

Table 2: Comparison of exercise and physical activity between prediabetic and normal subjects

Variables	Prediabet N=134	Normal N=116	P
Work index	2.13±0.63	2.11±0.53	0.748
Exercise index	2.19±0.79	2.18±0.75	0.886
Leisure index	2.36±0.79	2.21±0.55	0.101
Physical activity	6.67±1.49	6.45±1.22	0.209

* Correlation is significant at the 0.05 level (2-tailed).

It should be noted that any statistically significant differences have been not observed for muscle mass and mean body fat between the prediabetic and normal participants in the two female and male groups. Even though we observed significant differences in the visceral fat, BMI, WC, and WHR between prediabetic and normal participants just in the female group (p=0.010, p=0.037, p=0.002, p=0.000, respectively), the prediabetic participants exhibited higher levels of visceral fat, BMI, WC, and WHR in comparison to the normal participants. Finally, any anthropomorphic and body composition factors did not significantly differ between the prediabetic and normal participants in the male group (Table 3).

Table 3: Comparison of body composition parameters between prediabetic and normal subjects

Variables	Male			Female		
	Prediabet N=(103, 41.03%)	**Normal** N=(64, 25.49%)	**P**	**Prediabet** N=(30, 11.95%)	**Normal** N=(54, 21.51%)	**P**
Body fat (kg)	34.350	34.945	0.208	26.000	25.383	0.292
Muscle mass (kg)	26.597	25.752	0.335	38.050	37.466	0.619
Visceral fat (cm^2)	10.288	9.523	0.190	7.233	5.887	0.010**
BMI (kg/m^2)	26.891	26.336	0.314	25.860	24.479	0.037*
WC (cm)	87.366	86.667	0.643	79.759	74.472	0.002**
WHR (cm)	0.873	0.870	0.732	0.797	0.747	0.000**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
BMI: Body mass index, WC: Waist Circumference, WHR: Waist-to-hip ratio.

Table 4 reports the correlation coefficient between the variables. As seen in the table, all of anthropometric and body composition indices were significantly associated with blood glucose. In addition, a consistent correlation has been observed between the FBS and age (p=0.005).

Table 4: The correlation coefficient between variables and FBS

Variables	Pearson Correlation	Sig. (2-tailed)
Education (year)	.023	.713
Age (year)	.174**	.005
Body fat (kg)	.139*	.05
Muscle mass (kg)	-.197*	.005
Visceral fat (cm^2)	.278**	.000
BMI (kg/m^2)	.207**	.001
WC (cm)	.255**	.000
WHR (cm)	.293**	.000

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
BMI: Body mass index, WC: Waist Circumference, WHR: Waist-to-hip ratio.

DISCUSSION

This research assessed anthropomorphic and body composition differences in the prediabetes and normal participants. Based on the outputs, the prediabetes has been more prevalent in the male group. Moreover, we did not observe significant relationships between the level of education and FBS. However, just amongst the males, there has been a direct relationship between prediabetes pervasiveness and age, which has been enhanced with age. Actually, in the prediabetic group, the levels of the BMI, WC, visceral fat, and WHR have been statistically higher than the normal group just in the females. In general, FBS correlated with the body fat, visceral fat, muscle mass, WC, BMI, and WHR.

Conclusion of the present research showed that prevalence of prediabetes has been 52.98% (41.03% in the male and 11.95% in the female group). Hence, prediabetes had higher prevalence in the male group. It should be mentioned that findings of one of the national studies performed during 2006 in China is compatible with ours, in which the prediabetes had higher prevalence in the male in comparison to the female (W. Yang et al., 2010). In addition, other research demonstrated that parameters like the male gender, a family history of diabetes, older age, overweight, central obesity, obesity, greater heart rate, higher systolic blood pressure, greater levels of the serum triglyceride, educational level below the college degrees, and urban residence have been related to the greater risks of diabetes (Fathzadeh et al., 2010; W. Yang et al., 2010). In contrast, Abtahi et al. (2010) reported that prediabetes has higher prevalence among the female (Abtahi et al., 2010). Finally, it could be concluded that such inconsistencies can be due to the differences in the job or population being studied.

The present research showed that there is no relationship between prediabetes educational levels in the two genders. In addition, the similar studies conducted in Hong Kong (Ko et al., 2001) and in Iran (Azimi-Nezhad et al., 2008; Rahmanian, Shojaei, Jahromi, & Madani, 2016) found that there is not any significant relationships between the impaired glucose tolerance (IGT) and level of education. Moreover, one of the other studies demonstrated that there is not any relationship between oral glucose tolerance test (OGTT) in the participants with the age range of 35 to 74 years (Metcalf et al., 2008). However, some researchers claimed there is a relationship between prediabets and level of education (Kavanagh et al., 2010; Rathmann et al., 2005).

It is mentioned that the present research found a compatible association between the levels of FBS and age just in the male participants. Therefore, we proposed that aging is a risk factor interfering with the control of blood sugar (Rydén et al., 2007), which makes people susceptible to prediabetes. For example, Wenying et al. indicated the increased diabetes among the Chinese people with aging (W. Yang et al., 2010). Moreover, it has been found that prediabetes has an ascending pattern of the prevalence as the age increases (Abtahi et al., 2010). With regard to the increase of the aging population in Iran, prediabetes pervasiveness would enhance in the future. Hence, it is required to provide a procedure for monitoring prediabetes in order to prevent diabetes.

In this study, we did not observe any significant difference in exercise and physical activity between the two groups. In the event that, some studies have shown that exercise and mobility improve anthropomorphic, body composition indices and diabetes (Colip et al., 2016; Skrypnik et al., 2015; Tartibian, Kushkestani, & Ebrahimpour Nosrani, 2019; Yavari, Najafipoor, Aliasgarzadeh, Niafar, & Mobasseri, 2012). In present study, exercise may not have been effective because of different type, period and frequency of exercise.

In this study, we found that muscle mass was inversely related to blood glucose. This finding is consistent with Park et al. 2006 study that showed type 2 diabetes is associated with reduce skeletal muscle strength and quality (Park et al., 2006), also other study stated that diabetic individuals had subclinical functional restriction (De Rekeneire et al., 2003). Catabolism is a metabolic result of uncontrolled hyperglycemia, which dependent on the intensity, is associated by muscle protein breakdown and insufficient energy use, also diabetes accompanied with increased systemic inflammatory cytokines, such as tumor necrosis factor-α and interleukin-6, which affects muscle (Helmersson, Vessby, Larsson, & Basu, 2004; Taaffe, Harris, Ferrucci, Rowe, & Seeman, 2000; TEMELKOVA, Henkel, Koehler, Karrei, & Hanefeld, 2002; Visser et al., 2002). Another mechanism that has effects on muscle in diabetes individuals is the neuropathic processes involving motor neurons (Andersen, Poulsen, Mogensen, & Jakobsen, 1996; Andersen, Stålberg, Gjerstad, & Jakobsen, 1998; Brandon, Gaasch, Boyette, & Lloyd, 2003). In addition, studies have suggested that exercise can modulate the deleterious effects of hyperglycemia and diabetes on muscles through mechanisms such as GLUT4 translocation, activating AMP-activated protein kinase, metabolic control, insulin resistance, inflammatory markers, adipocytokines, and tissue expression of insulin receptor, and etc. in diabetes individual’s muscles (Jorge et al., 2011; Kennedy et al., 1999; Motahari-Tabari, Shirvani, Shirzad-e-Ahoodashty, Yousefi-Abdolmaleki, & Teimourzadeh, 2015; Musi et al., 2001)

According to this study findings, visceral fat, WC, BMI, FBS, and WHR have been greater in the prediabetic female compared to the normal female. In a similar study, Snodgrass et al. (2010) demonstrated that the level of fasting glucose has a positive association with the BMI just in the female (Snodgrass et al., 2010). Also, Bosi et al 2009 (Bosi et al., 2009) and Chin and Lin 2010 (Chen & Lin, 2010) indicated a correlation between prediabetes and BMI. Moreover, some researchers observed a positive association between prediabetes and BMI (Anjana et al., 2011; Cao et al., 2010). Furthermore, Gholi et al. (2019) revealed greater body fat, visceral fat, muscle mass, WC, BMI, FBS, and WHR in the prediabetic participants then the normal ones. Actually, abnormal body composition has been supported in the prediabetes (Gholi, Heidari-Beni, Feizi, Iraj, & Askari, 2016). Abtahi's study also observed greater prevalence of prediabetes with the elevated WC, BMI, and WHR, and obesity would be one of the risk factors for prediabetes. Moreover, it has been found that people having lower BMI would have lower susceptibility for progressing diabetes and prediabetes (Abtahi et al., 2010). Another study showed that when participants had the same anthropometric measures in the prediabetes and normal groups, any signiifcant difference has been not observed in t□eir blood glucose tests (Perreault et al., 2008). Additionally, in the case of the control of the body composition (WHR & BMI), differences in the insulin sensitivity among the diabetic and normal groups would be resolved (Bacha, Gungor, Lee, & Arslanian, 2009; Meyer et al., 2006; van Haeften et al., 2002). However, Lee et al. (2011) and Gupta et al.'s (2008) studies did not show any significant differences between BMI and prediabetes (Gupta, Greenway, Cornelissen, Pan, & Halberg, 2008; Lee et al., 2011).

As demonstrated in some studies, adipose tissue is employed as one of the storage sites for fatty acids. Moreover, it contributes significantly to the fat and glucose metabolisms and would produce a great content of hormones and cytokines. Hence, there is close relationship between extreme visceral obesity and elevating the occurrence of type 2 diabetes. In fact, intra-abdominal accumulation of adipose tissue has been considered as one of the major causes of diabetogenic dysfunction that would enhance the risks for type 2 diabetes (Despres, 2006).

As reported by the WHO, DM prevalence will be 6.8% in Iran in 2025 so that it will accounts for 15.1,000,000 of the Iranian population (King, Aubert, & Herman, 1998). It is notable that prevalence of diabetes is growing in Iran because of the population aging and greater range of visceral fat, WHR, WC, and BMI. In fact, approximately 1/2 of diabetics' people in Iran do not have awareness of this issue (Abtahi et al., 2010); therefore, the prediabetes screening programs would be helpful for people in order to have initial understanding of their disease and provide the ground for preventing diabetes and its consequences. In addition, exercise and physical activity can be a factor in preventing prediabetes.

CONCLUSIONS

It has been showed that anthropomorphic and body composition factors have differences between the prediabetes and normal participants. Thus, they may be used as the screening programs. Therefore, it is concluded that visceral fat, WC, BMI, and WHR can be the predictors of the risks of prediabetes. Also, exercise and physical activity can be a factor in preventing prediabetes.

Limitation

It would have been better if we measured several office centers separately for men and women instead of one office center

Conflict of Interests

The authors declare that there is no conflict of interest.

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