DOI: 10.37990/medr.1314861 Med Records 2023;5(Suppl 1):27-32

MEDICAL RECORDS-International Medical Journal

Research Article

The Efficacy of Medical Check-up Programs in Screening Healthy, Asymptomatic Individuals: A Cross-Sectional Study

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Abstract

Aim: Healthy asymptomatic individuals can be screened for various diseases using medical check-up programs. On the other hand, the prevalence of diabetes mellitus (DM) and prediabetes (PD), which are common metabolic disorders, are increasing worldwide. In this context, this study aims to determine the prevalence of DM and PD among the asymptomatic participants of a medical check-up program.

Material and Methods: The population of this cross-sectional study consisted of 440 healthy, asymptomatic volunteers aged 40 years or older who attended a medical check-up program conducted between January and August 2021. Patients with confirmed morbidities or regular medication use and pregnant women were excluded from the study. All study participants underwent physical examination, laboratory test, and sonographic assessment. The study participants were grouped according to their glycemic states, i.e., DM, PD, and normoglycemia (NG). The study's primary outcomes were the prevalence of DM and PD.

Results: The prevalence of DM and PD among the study participants was 12.5% (n=55) and 58.9% (n=259), respectively. The number of males was significantly higher in Group DM than in Groups PD and NG (p=0.014). Additionally, Group DM was significantly older than Groups PD and NG (p<0.001). Furthermore, there were significantly more participants in Group DM with high urea, creatinine, uric acid, triglyceride, and very low-density lipoprotein (VLDL) levels (p>0.05 for all cases).

Conclusion: The prevalence of DM and PD in presumed healthy asymptomatic participants was 12.5% and 58.9%, respectively, indicating unusually high prevalence in this population. In conclusion, the results of this study demonstrate that it is imperative that presumed healthy individuals are screened within the scope of medical check-up programs and followed closely afterward.

Keywords: Diagnostic screening programs, healthy subjects, diabetes mellitus, prediabetes, prevalence.

INTRODUCTION

Medical check-up programs featuring various laboratory and imaging investigations are commonly used to screen asymptomatic individuals to diagnose insidious diseases early (1). Different terminology is used to refer to medical check-up programs in different countries. Accordingly, medical check-up programs are also referred to as, among other things, check-up scans, periodic health examinations, periodic health checks, and routine health checks (1-7).

In addition to screening programs specifically designed to screen individuals with hematuria, chronic kidney disease, hyperuricemia, chronic diarrhea, fatty liver disease, and polyneuropathy (1-3,8-12), volunteer-based routine health examinations have become widespread in recent years (6). Such check-up programs allow for obtaining data about the epidemiological characteristics of chronic diseases (5). Additionally, volunteers who opt-in for medical check-up programs have unique characteristics compared to the patients admitted to hospitals to obtain health care (2). Increasing health awareness via health check-up programs reduces morbidity and mortality at an earlier stage (K).

Diabetes mellitus (DM) and prediabetes (PD) are among

CITATION

Mert A. The Efficacy of Medical Check-up Programs in Screening Healthy, Asymptomatic Individuals: A Cross-Sectional Study. Med Records. 2023;5(Suppl 1):27-32. DOI:1037990/medr.1314861

Received: 14.06.2023 **Accepted:** 24.08.2023 **Published:** 03.10.2023

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the most common metabolic disorders worldwide, with progressively increasing global prevalence (13,14). Early detection of PD is vital in preventing its progression to type 2 DM (T2DM). Therefore, timely recognition and introduction of simple lifestyle changes in voluntary people without known DM who underwent any check-up program might be beneficial in preventing any undesired consequences of DM in the future (14).

The number of studies covering the whole spectrum of medical check-up programs explicitly focusing on the prevalence of DM and PD in Türkiye is limited (1,15). In this context, this study was carried out to evaluate the asymptomatic participants attending a medical check-up program regarding the prevalence of DM and PD.

MATERIAL AND METHOD

Study Design

This study was designed as a cross-sectional study. The local ethical committee approved the study protocol (No: September 01, 2021-45). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Verbal informed consent was obtained from all participants.

Population and Sample

This study's population consisted of voluntary participants who attended a medical check-up program aimed at presumed healthy asymptomatic individuals conducted at the Family Medicine Outpatient Clinics of Hürrem Sultan Hospital located in İstanbul, Türkiye. Hürrem Sultan Hospital is a private hospital located in the centrum of Üsküdar city with 9000 monthly outpatient patient admissions. The records of the patients presented with various complaints to the family medicine outpatient clinics during the last eight months of 2021 were evaluated within the scope of the medical check-up program. Accordingly, individuals aged 40 years or older, without known morbidity, were informed about a newly purchased medical check-up program aimed at healthy, asymptomatic individuals over the phone between 10:00 AM and 5:00 PM on weekdays during the period between January and August 2021 and the individuals who opted in the program were scheduled to have the check-up.

In this context, 498 healthy, asymptomatic individuals were scheduled for a standard check-up between January and August 2021. Based on the interviews conducted by trained receptionists with these individuals during admission to the check-up unit, 58 individuals aged below 40 years, pregnant, or with confirmed morbidities or regular medication use were excluded from the study. Ultimately, the study sample consisted of 440 healthy, asymptomatic individuals.

Content of the Check-up Program

All participants who fasted overnight gave blood samples during the morning hours of the day they were scheduled to have the check-up. Afterward, they underwent an ultrasonographic examination of the abdominal organs. All imaging modalities were performed or interpreted by experienced radiologists. Depending on their gender, the participants were examined by a urologist or gynecologist at the hospital and then by a family physician with at least 28 years of experience. The family physician has taken anamnesis, performed a detailed physical examination, and interpreted the results of all clinical investigations. The family physician consulted with other departments at their discretion based on the results of the laboratory tests and imaging modalities.

Laboratory Tests

The hematological, biochemical, and hormonal tests performed in the context of the medical check-up program included the complete blood count test and measurements of the fasting plasma glucose, glycated hemoglobin (HbA1c), urea, creatinine, uric acid, alanine aminotransferase (ALT), aspartate aminotransferase (AST), triglyceride, cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) levels. The results of the laboratory parameters were categorized as low, normal, or high based on the predefined limits for each parameter.

Definitions

HbA1c values of ≥6.5% and/or fasting glucose levels of ≥126 mg/dL were considered to indicate the diagnosis of DM (3). On the other hand, HbA1c values between 5.7% and 6.4% and fasting glucose levels between 100 mg/dL and 125 mg/dL were considered to indicate the diagnosis of PD (16).

Variables and Groups

Demographic characteristics, including age, gender, smoking history, laboratory characteristics, and imaging findings, were prospectively recorded. The participants were stratified into subgroups based on whether they had DM (Group DM) or PD (Group PD). The remaining participants with fasting glucose levels of <100 mg/dL or HbA1c <5.7% were included in the normoglycemia group (Group NG).

Statistical Analysis

The study's primary outcomes were the prevalence of DM and PD in the study group. In contrast, the secondary outcomes were the differences between the participants with and without DM and PD.

Descriptive statistics obtained from the collected data were expressed as mean±standard deviation values in the case of continuous variables determined to conform to the normal distribution, as median with minimum-maximum values in the case of continuous variables determined not to conform to the normal distribution, and as numbers and

percentage values in the case of categorical variables. The Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests were used to analyze the normal distribution characteristics of the numerical variables.

In comparing the differences between categorical variables, Pearson's chi-square and Fisher's exact tests were used in 2x2 tables, and the Fisher-Freeman Halton test was used in RxC tables.

The one-way analysis of variance (ANOVA) and Kruskal-Wallis tests were used to compare more than two independent groups where numerical variables were determined to conform and not to conform to the normal distribution, respectively. The differences between the groups were evaluated with Games-Howell or Tukey tests depending on the heterogeneity of the data if parametric tests were applied and with the Dwass-Steel-Critchlow-Fligner test if non-parametric tests were applied.

Jamovi project 2.3.24.0 (Jamovi, version 2.3.24.0, 2023, retrieved from https://www.jamovi.org) and JASP 0.17.1 (Jeffreys' Amazing Statistics Program, version 0.17.1, 2023, retrieved from https://jasp-stats.org) software packages were used in the statistical analyses. The probability (p) statistics of ≤0.05 indicated statistical significance.

RESULTS

There were 55 and 259 participants in Groups DM and PD, respectively. The prevalence of DM and PD were 12.5% and 58.9%, respectively. Significant differences in demographic characteristics were detected between the groups (p<0.05). Accordingly, the participants in Group NG were significantly younger than those in Groups PD and DM (p<0.001). In addition, the participants in Group DM were significantly older than Group PD participants (p<0.001). The rate of male participants was significantly higher in Group DM than in other groups (p=0.01). There was no significant difference between the groups in smoking status (p=0.35) (Table 1).

There were significant differences between the groups in the laboratory parameters related to the glycemic profile of the participants (p<0.05) (Table 2). The median fasting blood glucose and HbA1c values in Groups DM, PD, and NG were 138 mg/dL and 7.1%, 104 mg/dL and 5.8%, and 93 mg/dL and 5.4%, respectively (Table 2).

The comparison of the groups in terms of laboratory results indicating pathology revealed significant differences between the groups (p<0.05) (Table 3). Accordingly, there were significantly more participants in Group DM with high urea, creatinine, uric acid, triglyceride, and VLDL levels than in other groups (Table 3).

The sonographic assessment of the groups regarding hepatosteatosis revealed significant differences (p=0.03). Accordingly, the number of participants with Grade 1 hepatosteatosis was significantly lower in Group DM than in the other groups. Additionally, the number of participants with Grade 2 hepatosteatosis was significantly higher in Group DM than in Group NG (41.2% vs. 16.7%) (Table 4).

Table 1. Demographic characteristics and smoking history of the study groups

	Groups			
	Group DM (n=55)	Group PD (n=259)	Group NG (n=126)	p
Age (year) †	58.0±12.6	47.1±11.2	39.7±12.0	**<0.001**, *****
Sex ‡				
Female	23 (41.8) a	158 (61.0) b	81 (64.3) b	**0.014***
Male	32 (58.2) a	101 (39.0) b	45 (35.7) b	
Current smoker ‡	9 (16.4)	50 (19.3)	31 (24.6)	0.348*

‡: n (%), †: mean±standard deviation; a, b: different letters in each row show statistical differences; DM: diabetes mellitus, PD: prediabetes, NG: normoglycemia; *. Pearson Chi-Square test, **. One-way ANOVA test, ***. Tukey test.

Table 2. Laboratory parameters related to the glycemic profile of the participants in the groups

	Groups			
	Group DM (n=55)	Group PD (n=259)	Group NG (n=126)	p
Fasting blood glucose (mg/dL) §	138.0 [85.0–372.0]	104.0 [81.0–125.0]	93.0 [67.0–99.0]	**<0.001*, ****
HbA1c (%) §	7.1 [5.5–11.7]	5.8 [5.0–6.4]	5.4 [4.7–5.6]	**<0.001*, ****

§: median [min-max]; DM: diabetes mellitus, PD: prediabetes, NG: normoglycemia; *. Kruskal Wallis-H test; **. Dwass-Steel-Critchlow-Fligner test for pairwise comparisons

Table 3. Comparison of the participants with pathological laboratory results between the groups

		Groups			
		Group DM (n=55)	Group PD (n=259)	Group NG (n=126)	p*
Hemoglobin ‡	Low ‡	5 (9.1)	28 (10.8)	15 (11.9)	0.853
Leukocyte count	Leukopenia ‡	0 (0.0)	1 (0.4)	1 (0.8)	0.704
	Leukocytosis ‡	1 (1.8)	10 (3.9)	2 (1.6)	
Platelet count	Thrombocytopenia ‡	2 (3.6)	2 (0.8)	1 (0.8)	0.268
	Thrombocytosis ‡	0 (0.0)	3 (1.2)	0 (0.0)	
Urea	High ‡	10 (18.2) a	21 (8.1) b	5 (4.0) b	**0.012**
Creatinine	High ‡	7 (12.7) a	10 (3.9) b	2 (1.6) b	**0.011**
Uric acid	High ‡	9 (16.4) a	15 (5.8) b	8 (6.3) b	**0.039**
Alanine aminotransferase	High ‡	5 (9.1)	12 (4.6)	5 (4.0)	0.306
Aspartate aminotransferase	High ‡	4 (7.3) a	3 (1.2) b	4 (3.2) a b	**0.023**
Triglyceride	High ‡	29 (52.7) a	87 (33.6) b	33 (26.2) b	**0.002**
Cholesterol	High ‡	34 (61.8)	178 (68.7)	74 (58.7)	0.135
Low-density lipoprotein	High ‡	30 (54.5) a	144 (55.6) b	52 (41.3) a	**0.027**
High-density lipoprotein	High ‡	16 (29.1)	103 (39.8)	58 (46.0)	0.099
Very low-density lipoprotein	High ‡	29 (52.7) a	83 (32.0) b	32 (25.4) b	**0.001**

‡: n (%); a, b: different letters in each row show statistical differences; DM: diabetes mellitus, PD: prediabetes, NG: normoglycemia; *. Pearson Chi-Square/Fisher Freeman Halton test

Table 4. Distribution of hepatosteatosis grades according to the sonographic examination

	Groups			
	Group DM (n=55)	Group PD (n=259)	Group NG (n=126)	p
Hepatosteatosis grades ‡				
1	17 (50.0) a	91 (71.1) b	30 (83.3) b	
2	14 (41.2) a	34 (26.6) a, b	6 (16.7) b	**0.026***
3	3 (8.8) a	3 (2.3) a	0 (0.0) a	

‡: n (%); a, b: different letters in each row show statistical differences; DM: diabetes mellitus, PD: prediabetes, NG: normoglycemia; *. Fisher Freeman Halton test

DISCUSSION

This study's results indicated that the prevalence of DM and PD among the presumed healthy participants who attended a medical check-up program was 12.5% and 58.9%, respectively. In addition, it was determined that patients with DM were more likely to have increased urea, creatinine, triglyceride, and VLDL levels than patients with PD and normoglycemic individuals.

Varying prevalence rates have been reported in the literature for DM and PD in presumed healthy individuals participating in medical check-up programs. In a study by Tangjittipokin conducted in Thailand (17), the prevalence of DM and PD in the said population was reported as 1.07% and 54.3%, respectively. In two studies conducted in India, the prevalence of DM and PD in the population was reported as 17.18% and 12.3%, and 35.93% and 37.7%, respectively (6). In a multicenter study conducted in Croatia, hemoglobin A1c-based screening revealed that the prevalence of DM and PD in presumed healthy Croatian adults ranged from 3.3% to 7.3% and 14.2% to 20.5%, depending on the hospital setting (13). The lower PD prevalence found in the study compared to the studies mentioned above may be attributed to a Mediterranean diet. A real-world study from China reported that the overall prevalence rates for DM and PD were 8.0% and 27.6%. This study included 15.8 million adults screened in 519 Meinian health check-up centers across 243 cities (18). The authors thought that the absence of postprandial glucose measurements in the health check-

up assessments might be a factor for the differences in the prevalence rates of PD. The current study used fasting blood glucose measurements and HbA1c levels. In another study conducted in China, impaired fasting glucose levels were detected in 8.97% of the individuals who underwent a health check-up during the follow-up period (14). They concluded that assessing impaired fasting glucose levels using a predictive model could help control DM and its cardiovascular complications. Degertekin et al. (15) reported that 8.1% of the 113239 presumed healthy subjects who underwent check-ups across Türkiye had DM. The varying prevalence between these studies may be attributed to the differences in methodologies, demographic characteristics, and participants' lifestyles. Different inclusion and diagnostic criteria also influenced the generalizability of these findings. Therefore, future studies must be adjusted for such confounding variables to obtain more reliable results.

Non-alcoholic fatty liver and steatohepatitis impose significant health burdens on diabetic and prediabetic individuals (5,19). It has been shown that changes in a fatty liver were a risk factor for the development of diabetes in prediabetic people (10). Studies from different parts of the World reported varying prevalence for fatty liver and steatohepatitis in participants who participated in general health check-ups. In one of these studies conducted in India, Kumar et al. (18) determined that almost one-third of diabetic and prediabetic individuals had elevated transaminase levels. In addition, the prevalence of sonographically detected fatty liver in individuals diagnosed with DM and PD due to a medical check-up program was 57.6% and 46.4%, respectively. Morinaga et al. (20) found an association between increased serum ALT levels and the future development of DM in the general Japanese population. To screen the general population for the prevalence rates of liver steatosis and fibrosis, Man et al. (21) detected a rate of 44.39% for steatosis among 5.7 million Chinese adult people. They also found that elevated transaminases were significantly associated with steatosis and fibrosis. In a study conducted in Türkiye analyzing 10-year data of presumed healthy individuals who participated in a check-up program in a private hospital group, the prevalence of non-alcoholic fatty liver disease was found as 48.3% (15). In comparison, in this study, 9.1% and 8.8% of the participants, who were found to be diabetic due to the check-up program, had elevated ALT levels and grade 3 hepatosteatosis, respectively. There was no significant difference between the groups in the rate of the participants with elevated liver transaminases or grade 3 hepatosteatosis. It may be that the number of participants with laboratory and imaging findings confirming their morbidity was too low to reach statistical significance. Kitazawa et al. (10) recommended the fatty liver index as an effective tool to predict the development of DM in individuals with PD. Thus, increased serum transaminases might be considered the risk factor for developing future glycemic problems during medical check-up programs. Consideration of such laboratory results and sonographic imaging findings seems to be a beneficial approach in shaping future pathways for screening and risk stratification (21). Large-scale studies are needed to evaluate further the relationship between the glycemic status and fatty changes in the liver among presumed healthy people participating in check-up programs.

Limitations of the Study

This cross-sectional study was conducted at a family medicine clinic of a private hospital. Therefore, the prevalence reported in this study may be different from other populations. A large-scale, multicenter study is needed to obtain more reliable findings. The lack of detailed clinical characteristics of the participants may be a study limitation. Additionally, the fact that impaired fasting glucose or glucose tolerance statuses were not addressed may be another limitation of the study.

CONCLUSION

The prevalence of DM and PD found in presumed healthy asymptomatic participants included in this study indicated an unusually high prevalence in this population. In conclusion, the results of this study demonstrate that it is imperative that the presumed healthy individuals are screened within the scope of medical check-up programs and followed closely afterward.

Financial disclosures: *The authors declared that this study has received no financial support.*

Conflict of Interest: *The authors declare that they have no competing interest.*

Ethical approval: *The protocol of this study was approved by the Local Ethical Committee of Hürrem Sultan Hospital (Approval Date and Number: 01.10.2021 and 45). The study was conducted in accordance with the principles of the Declaration of Helsinki.*

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