Diabesity: obesity as a risk for diabetes mellitus type 2

Belavić, Anja

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UNIVERSITY OF ZAGREB

SCHOOL OF MEDICINE

Anja Belavić

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GRADUATE THESIS

Zagreb, 2015

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This graduation paper was made at Chair for Medical Statistics, Epidemiology and Medical Informatics, University of Zagreb School of Medicine under the supervision of Asst. Prof. Sanja Musić Milanović and it was submitted for evaluation in the academic year 2014/2015.

Abbreviations

T2DM: Type 2 Diabetes Mellitus

CAHS: Croatian Adult Health Survey

BMI: Body Mass Index

WHO: World Health Organization

CDC: Centers for Disease Control

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Summary

Title: Diabesity: Obesity as a Risk for Diabetes Mellitus Type 2

Keywords: Diabetes mellitus, obesity, overweight, epidemiology, prevalence, weight gain

Author: Anja Belavić

Obesity has long been considered a product of the modern life style in developed countries. Its increasing frequency in developing countries, however, points to a global paradox: a double burden of a still unsolved problem of malnutrition and of the epidemic of obesity and its comorbidities such as diabetes, hypertension, cancer and cardiovascular disease. Worldwide obesity has almost doubled since 1980. Our aim was to determine how prevalent overweight and obesity was in a population of persons diagnosed with type 2 diabetes, and to compare our results with results from the Croatian Adult Health Survey. In this retrospective observational study we investigated the prevalence of obesity in persons with type 2 diabetes by calculating body mass index. Data on 166 diabetic patients (82 males and 84 females) were obtained from the University Hospital Dubrava outpatient clinic between the dates of July 1 2013 and December 31 2014. The descriptive statistics that we extrapolated were age, duration of disease from the official diagnosis, height, weight, body mass index, waist circumference, and blood pressure values. Body mass index was calculated for almost all of the people for which had the necessary parameters of height (m) and weight (kg). We found that in people diagnosed with type 2 diabetes more than 90 percent of persons had a body mass index equal to or greater than 25 kg/m^2, indicating overweight and obese. Our findings suggest that type 2 diabetic people are three times more likely to be obese in

comparison to the general population, and difference is highly statistically significant. Further, obesity and type 2 diabetes do have a significant positive correlation (p<0.001). Obesity is the most important modifiable risk factor for type 2 diabetes and the majority patients with diabetes are overweight or obese.

Preface

This thesis is made as a completion of the medical English program in Zagreb, Croatia. It was written by me, Anja Belavic, with the help of my mentor Asst. Prof. Sanja Musić Milanović. I have studied medicine for 6 years at the University of Zagreb and have chosen to do my thesis at the Epidemiology department, because I felt that this was an important area of medicine, in which trends, risk factors, and significant statistics could be analyzed and further make contributions to the care and treatment of patients. I choose to address obesity and diabetes because this is a worldwide epidemic that is not only affecting developed countries, which many of my colleagues and I live in, but also the developing world, and it is having a great impact on medicine as a whole. This thesis is targeted at students and doctors alike, so that they may have statistical evidence showing the correlation between obesity and diabetes, in different age groups and between the different genders, in comparison to the general population. This thesis was written in Zagreb, Croatia in the 2014/2015 academic year.

Hypothesis

Obesity is significantly higher in adult patients with type 2 diabetes in comparison with general adult population in Croatia, for at least double.

Objectives

The primary objective of this thesis was to determine the prevalence of obesity in our sample group of people diagnosed with type 2 diabetes mellitus (T2DM), and to compare results to the general population in Croatia which has been retrieved from Croatian Health Adult Survey (CAHS) results. Data was extracted from the outpatient clinic for diabetes at University Hospital Dubrava, for a fixed time period (1st July 2013 – 31st December 2014). Data collected was relevant in helping to determine the correlation of obesity and T2DM. Body mass index (BMI) was used as our measure to categorize people as normal, overweight, and obese. Other parameters that were observed are the age, gender, duration of disease, waist circumference and blood pressure. We determined of all of the people in the allotted time frame diagnosed with T2DM, that have a BMI equal or greater than 25 kg/m^2 considered by the World Health Organisation (WHO) as the definition of obesity (1). The data collected was statistically analyzed and reviewed.

Introduction

Obesity has long been considered a product of the modern life style in developed countries. Its increasing frequency in developing countries, however, points to a global paradox: a double burden of a still unsolved problem of malnutrition and of the epidemic of obesity and its comorbidities such as diabetes, hypertension, cancer and cardiovascular disease (2). Worldwide obesity has almost doubled since 1980 (1).

The current epidemic of obesity has been reported in several but not all regions globally (3). The "nutrition transition" is a rather benign-sounding name for a striking and fast-moving phenomenon: a global epidemic of obesity (2). Over the past decades advanced work technology, sedentary leisure-time behaviour, and greater availability, lower cost and enhanced flavour of food have led to an energy imbalance (4). Evidently major weight gain can occur with a very small imbalance between intake and expenditure. Obesity is very commonly linked with chronic diseases by increasing the risk of their onset, and also affecting their course and determining their treatment and prognosis (5). The Center for Disease Control and Prevention (CDC) state that women with a BMI of 30 kg/m^2 have a 28 times greater risk of developing diabetes than do women of normal weight (6). Diabetes is a chronic disease closely associated with obesity, and with the advancements in society and changes in lifestyles of developed and developing countries, there is a growing prevalence and parallel between these two diseases. Obesity is the leading risk factor for T2DM (7). Obesity is affected by a complex interaction between the environment, genetic predisposition, and human behavior. It is well known that excess bodyweight induces or aggravates insulin resistance, which is a characteristic feature of T2DM, although the exact mechanisms are not clear. T2DM patients who have lost weight have significantly better diabetes control (8) and

even their intention to lose weight is associated with a reduced risk of all-cause mortality, independent of whether they actually lose weight or not (9).

Material and Methods

To examine the association between T2DM and body weight, BMI was determined in 166 people with T2DM (82 men and 84 women). Data was obtained from University Hospital Dubrava outpatient clinic. Descriptive statistics were acquired form discharge letters of patients from July 1st 2013 through to December 31st 2014. The data that was relevant to us was incorporated into an excel spreadsheet which was then analyzed. Microsoft excel was used to organize and evaluate parts of the data, such as grouping into male and female and further into age groups with appropriate calculated average BMIs for each, as well as separating into groups of obese, overweight and normal so that further prevalence may be assessed.

Data was analysed using STATISTICA ver.10 (ID: STA999K347150-W) on α-error 0.05.

BMI was calculated as weight (kg) divided by the square of height (m), which was previously calculated for most people. In cases where BMI was not available and height and weight were recorded an online calculator was used (10). Other data that was assessed was gender, age, disease duration, waist circumference and blood pressure. Mean and median were calculated for each of the parameters, as well as the standard deviation. Values obtained for BMI were grouped as obese (BMI $\geq$30 kg/m^2), overweight (BMI 25-30 kg/m^2), and normal (BMI $\leq$25 kg/m^2). Of the total 166 people 82 were men and 84 women. The prevalence of overweight, obesity and central obesity was obtained from results from the CAHS. The results from the CAHS survey were separated into BMI 25-30 kg/m^2 and BMI $\geq$30 kg/m^2. Furthermore both were divided into number of total participants, and by gender.

Results

Out of 166 people, BMI was able to be obtained or calculated for 163. The average BMI was calculated to be 32.75 kg/m^2. The average age was calculated to be 63 years, with a minimum of 38 years and a maximum of 89 years (total observed 166) (Fig.1). The average weight (164 entries) was calculated to be 92.1 kg (Fig.2), with a minimum of 49 kg and maximum of 157 kg. The average height (164 entries) was calculated to be 166.9 cm, with a minimum of 144 cm and maximum of 200 cm. The average waist circumference (138 entries) was found to be 111.6 cm (Fig.3), with a minimum of 65 cm and maximum of 153 cm. On average the disease duration was found to be 10.6 years (Fig.4), minimum of 1 year and maximum of 36 years (108 entries).
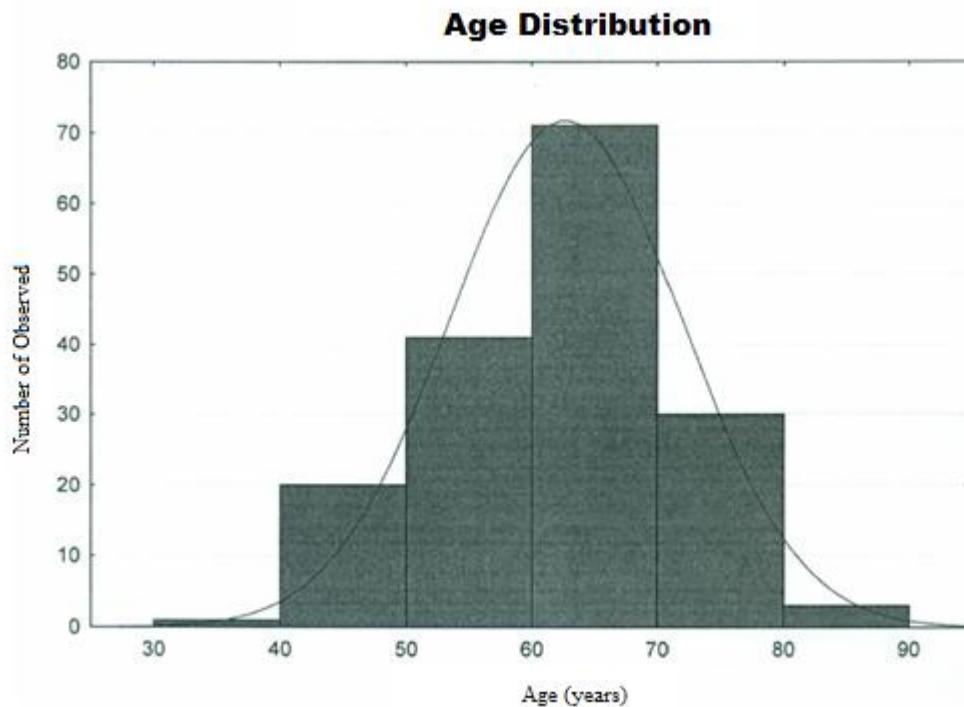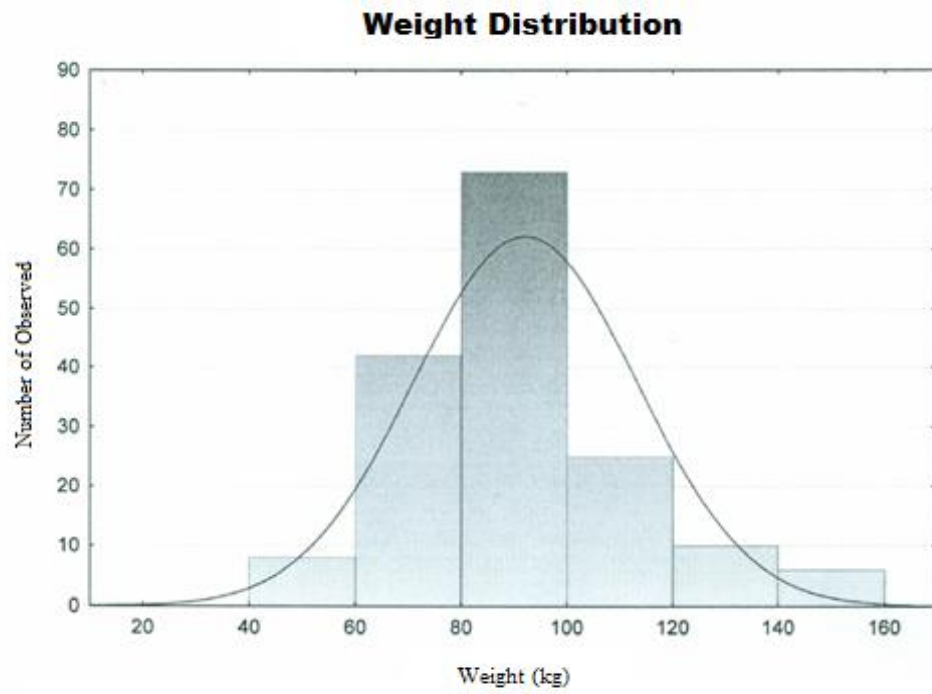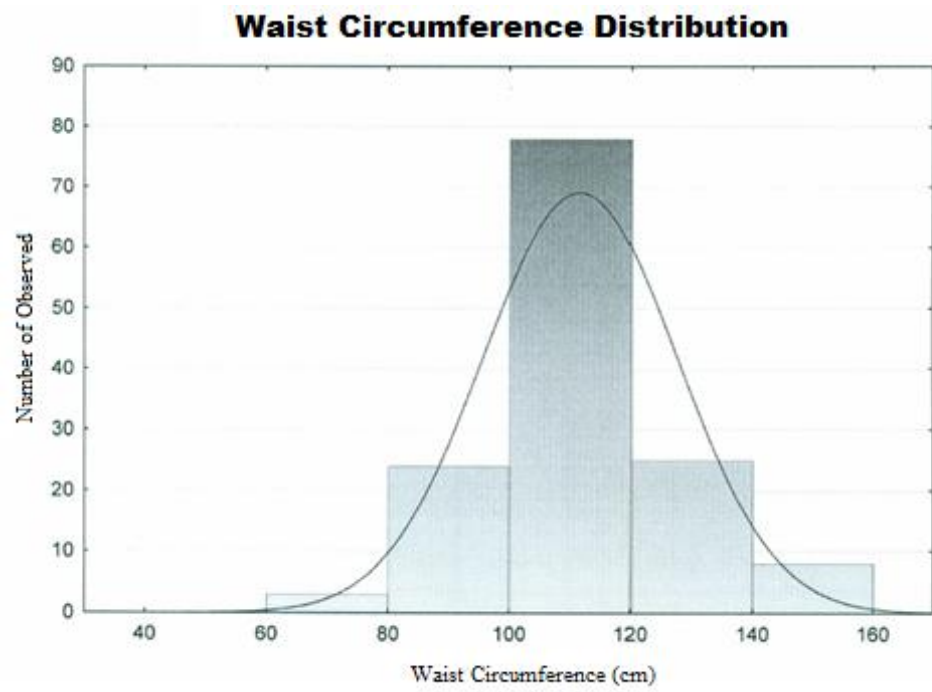

Fig.1

Weight Distribution

Fig.2

Waist Circumference Distribution

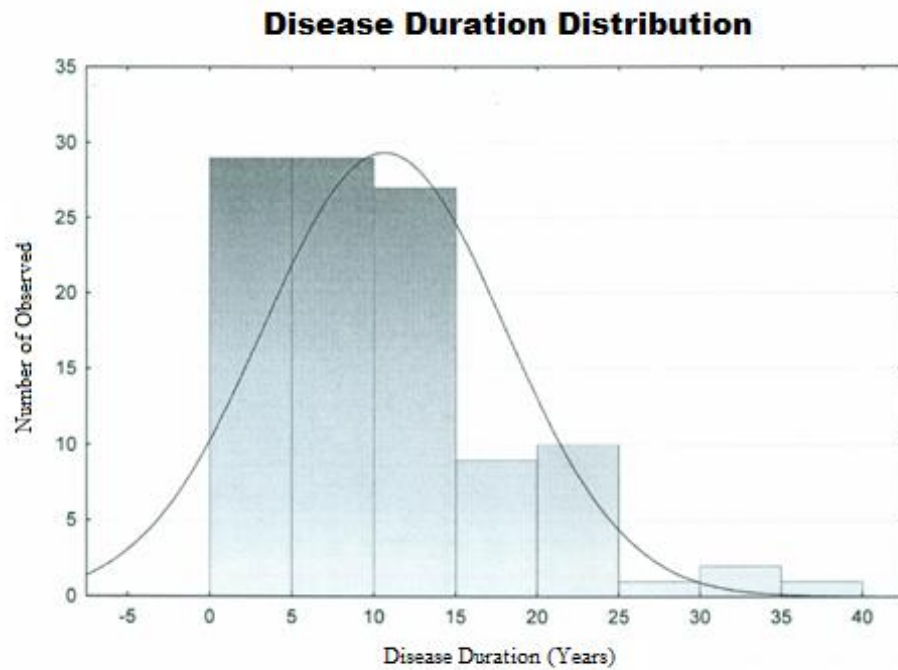*Fig. 3*

Disease Duration Distribution

Fig. 4

Prevalence of overweight and obesity

To establish the prevalence of overweight and obesity in the investigated people, they were divided into groups according to their BMI values (Group 1 consisted of subjects with BMI <25 kg/m^2, Group 2 of overweight subjects with 25 kg/m^2 ≤BMI <30 kg/m^2, and Group 3 consisted of obese subjects with BMI ≥30 kg/m^2). Out of the total number of studied people, 63% (103/163) were obese, 26% (42/163) were overweight, and 11% (18/163) were normal.

A histogram was used to represent the values of BMI (Fig.5) with a minimum of 18.5 kg/m^2 and maximum of 52.7 kg/m^2 (Total 163). Further separated into the three groups (Fig.6). The results of the Croatian Adult Health Survey showed that overall, the prevalence of overweight and obesity for the entire population of Croatia was estimated as 38.11% and 20.34%, respectively.
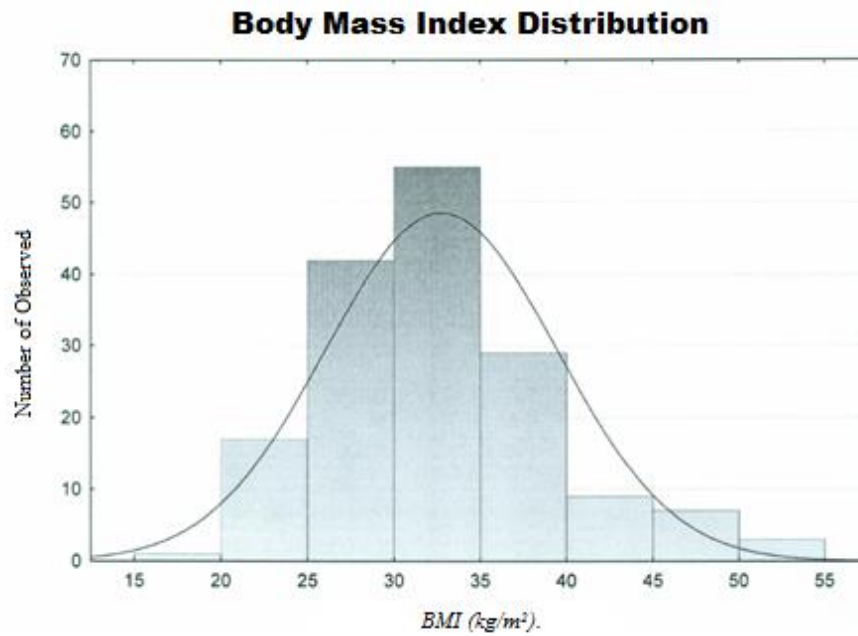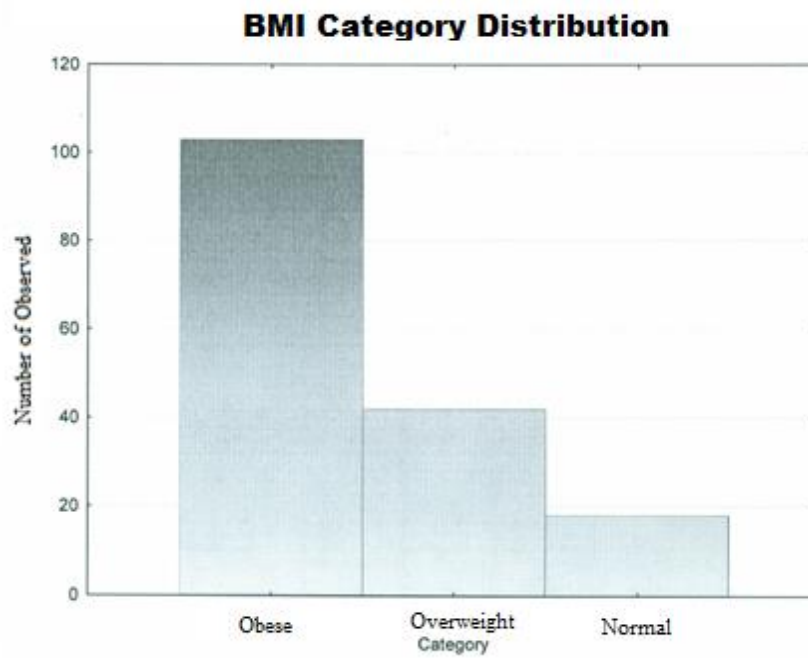
Fig.5

Fig. 6 – Number of observed categorized as obese (≥30 kg/m²), overweight (25-30 kg/m²), and normal (<25 kg/m²).

Analysis of prevalence and association of results of this study to results obtained from general population in Croatian Adults
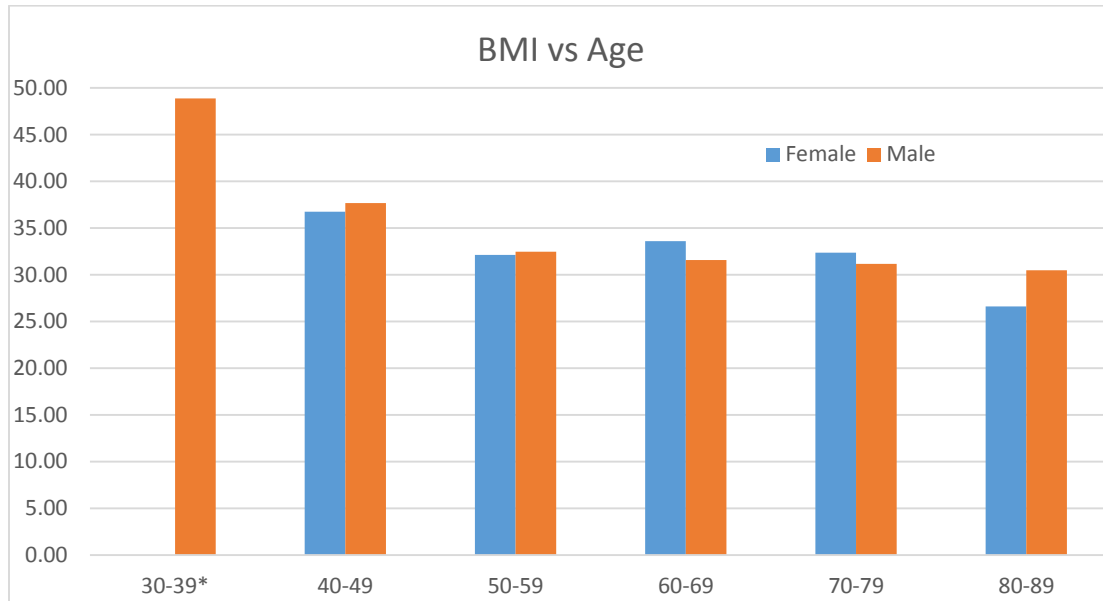
Overall, the prevalence of overweight and obesity for the entire population of Croatia was estimated for men to be 43.2% and 20.1%, respectively, and for women 33.6% and 20.6%, respectively for the indicators of body weight. To establish the prevalence of overweight and obesity in our study people were separated into male and female, as well as into 2 groups, overweight (BMI 25-30 kg/m^2) and obese (BMI $\geq$30 kg/m^2). Out of the total number of studied persons 30.5% (25/82) of men and 19.0% (16/84) of women were overweight, and 57.3% (47/82) of men and 69.0% of women were obese.

A statistically significant difference was found in the degree of obesity between persons with type 2 DM in our study and the general population of Croatia (p<0.001). A borderline significance was found in the degree of overweight in our study and the general population of Croatia (p=0.055).

Prevalence of obesity in specific age groups

People were separated by gender and by age groups (a decade for each group) so that prevalence of obesity may be observed as a factor of age. An average BMI was estimated for each decade of females which resulted in, 40-49 years with a BMI of 36.75 kg/m^2 (8/84), 50-59 years a BMI of 32.13 kg/m^2 (18/84) 1 person without a calculated BMI, 60-69 years a BMI of 33.61 kg/m^2 (38/84), 70-79 years a BMI of 32.38 kg/m^2 (16/84), and 80-89 years a BMI of 26.60 kg/m^2 (4/84). An average BMI was estimated for each decade of males which resulted in, 30-39 years with a BMI of 48.9 kg/m^2 (1/82), 40-49 years with a BMI of 37.69 kg/m^2 (7/82), 50-59 years a BMI of 32.48 kg/m^2 (21/82) 1 person without a calculated BMI, 60-69 years a BMI of 31.57 kg/m^2 (36/82)

1 person without a calculated BMI, 70-79 years a BMI of 32.38 kg/m^2 (16/82), and 80-89 years a BMI of 30.50 kg/m^2 (1/82) (Fig. 7).

*Fig. 7 – Persons grouped by gender and further separated by age groups (10 year groups). *Single entry for 30-39 years.*

Discussion

The prevalence of overweight and obesity in people with T2DM in our observed people was found to be higher than that of the general population of Croatia, the results being comparable to those of the CAHS. These results confirm previously published conclusions that there is a significant prevalence of obesity in the population diagnosed with T2DM versus the normal populations (11). People were sorted into groups, normal with a BMI ≥ 25 kg/m^2, overweight with a BMI 25-30 kg/m^2, and obese with a BMI ≥ 30 kg/m^2. As we can see from our results 89% of our observed people were overweight or obese normal BMI only accounted for 11%, which is a significant proportion of people as compared to the general population in Croatia which was estimated at 58%. We expected that the prevalence of obesity in our study of people with T2DM would be statistically significant and higher in comparison to the general population, and this was what our results had shown. We found that 63% of our total observed were classified as obese, BMI≥ 30 kg/m^2, whereas only 20% of the general population was estimated to be obese. Highly statistically significant difference was found in the degree of obesity between people with T2DM in our study and the general population of Croatia (p<0.001). This is a common and expected finding that has been previously shown in a variety of studies, and because diabetes has now become a worldwide epidemic and is no longer only diagnosed in developed countries but as well in developing countries (12).

To further asses the prevalence of overweight and obesity we separated our results according to gender so that we may see the trends between males and females. Similarly to our findings in the overall population we found that 87% of males in our study have a BMI ≥ 25 kg/m^2 in contrast with 63% of males in the general population. This again shows us that overweight and

obesity are more prevalent in people with diabetes. The occurrence of obesity in males in our study was 57% in comparison with 20% in the general population, and for overweight 30% and 43% respectively. As we can see from these results the prevalence of obesity seems to be significantly increased in men by 37%, whereas the difference in overweight is 13% in with more of the general population classified as overweight. From our results we are able to conclude that occurrence of obesity in our studied population was substantial. Our results correlate with other studies that have been previously conducted to show the relationship of obesity and T2DM in the male population, stating in one study that 86% of those with T2DM are overweight or obese (13).

We found our results of the studied females to be similar in findings to our male group and further confirm the prevalence of obesity in T2DM. 88% of observed females had a BMI $\geq$25 kg/m^2 in contrast to 54% of the estimated general population of Croatia. This proceeded to support our hypothesis that occurrence of overweight and obesity was more common in people with diabetes. The occurrence of obesity in females in our study was 69% in comparison with 21% in the general population, and for overweight 19% and 34% respectively. As we saw with the male population the same trend can be seen within the females, with a 48% higher occurrence of obesity in people with diabetes, and 15% higher prevalence of overweight in the general population. As we can see amongst females with diabetes there is a higher incidence of people considered obese. Our results support the results of other studies done previously within the female population of T2DM (14).

By grouping our observed people into gender, and further by age groups of every ten years, we were able to analyze in which age groups obesity was most prevalent in our study. We found that males 40-49 had the highest average BMI which was calculated to be 37.7 kg/m^2 (omitting

30-39 age group due to 1 entry), and females also were 40-49 age group with an average BMI of 36.8 kg/m^2. In conclusion we can see that for both males and females on average the highest BMIs were in the 40s. A survey done by the Public Health Agency of Canada showed that obesity peaked in individuals aged 60 to 69 years and declining thereafter, with an almost equal prevalence between males in females between those ages (14). A study done of an adult population with newly diagnosed T2DM showed that there exists the inverse linear relationship of obesity and age of diabetes onset which suggests that obesity is a continuous risk rather than a threshold risk for diabetes onset (15). Although the rates of obesity on average are still the highest in older age groups it is becoming more prevalent in younger age groups leading to a greater occurrence of T2DM amongst younger people, due to its association as a risk factor. Overweight and obesity result from an energy imbalance. Over time, when people eat and drink more calories than they burn, the energy balance tips toward weight gain, overweight, and obesity. We know that society has changed over the last 30 years, and in this time we have seen growing rates of obesity, and along with it diabetes, which has also become more prevalent in younger populations. We can attribute this growth with sedentary lifestyles, people spending more time in front of televisions and computers, depending on cars to get from point A to point B more often now.

Although waist circumference and BMI are interrelated, waist circumference provides an independent prediction of risk over and above that of BMI (16). Long-term follow-up studies showed that so-called "abdominal obesity" was strongly associated with an increased risk of T2DM, cardiovascular disease and death, even after controlling for BMI (17). We did not use waist circumference as a parameter for determining obesity, but it has shown to be of value in classifying people as obese. The International Diabetes Federation defines abdominal obesity as women who have > 80 cm waist circumference and men > 90 cm. In our results we found that the average waist

circumference was 111.6 cm, indicating that on average in our observed group, persons would be classified as abdominal obese, which puts them at a greater risk for diabetes. It would be beneficial for future studies to assess the waist circumference as well as the BMI and to compare the results so that a more detailed and analyzed conclusion may be drawn, but this was beyond the scope of our study.

We performed a small retrospective observational study that gave us a small insight in the prevalence of obesity in an outpatient clinic at University Hospital Dubrava. T2DM people were found to be 3 times more likely to be obese in comparison to the general population, and difference is highly statistically significant. Since we have seen the prevalence of obesity to be of significance in this population, it would suffice to say that with proper control of weight, through eating habits and physical activity that the prevalence of obesity in diabetics may be improved.

Conclusion

In conclusion we can say that we have observed a substantial prevalence of obesity in people with T2DM which was statistically significant. Information was collected retrospectively, which caused some data to be missing. In our sample (166 people) we were able to show that obesity has a greater occurrence in certain age groups and that obesity is significantly higher than the prevalence in the entire population, although this was not the case with people categorized as overweight. We were also able to demonstrate that male and female average BMIs were close in value (m= 32.5 kg/m^2 f= 33.0 kg/m^2). We have observed that almost 90% of people in our study have a BMI ≥25 kg/m^2. Close to 60% of the population of Croatia is considered to be overweight or obese, which is less than that of people in our study with diabetes, but it is still a health problem that leads to many disturbances in the health of the population. The epidemic of obesity is not limited to the Croatia and developed countries but has been documented in several regions worldwide, with the prevalence of obesity rising in most countries. Obesity is affected by a complex interaction between the environment, genetic predisposition, and human behavior. It is associated with an increased risk of numerous chronic disease. It is important to continue to study the relationship of diabetes and obesity in the future, as well as implement strategies and plans so that obesity which is considered a modifiable risk factor can help with decreasing the incidence of T2DM. In addition, the obesity epidemic creates a strain on the economy with its massive healthcare costs. The problem of overweight and obesity has therefore emerged as one of the most pressing global issues that we will face during the next several decades, and demands attention from the healthcare community, researchers, and policy makers (4), and in order to help lower the number of people diagnosed with T2DM, we must address the increasing statistics of obesity.

Acknowledgements

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Biography

Anja Belavić was born in Livno, Bosnia and Hercegovina, and moved to Barrie, Ontario, Canada with her parents in 1993. She finished High School at St. Joan of Arc in Barrie, ON and shortly after was enrolled at the University of Zagreb in 2009. She started Medicine at the University of Zagreb School of Medicine in Croatia where she plans to graduate in July of 2015. She has a passion for medicine, amongst many other things, she likes to learn new things, and is excited to know that she has chosen a career in which she will be able to do this for the rest of her life. She is interested in a variety of fields of medicine, such as pediatrics and family medicine.