Obesity Medicine 15 (2019) 100110

Contents lists available at ScienceDirect

Obesity Medicine

journal homepage: www.elsevier.com/locate/obmed

Association of serum calcium level with body mass index among type 2 diabetes patients in Palestine

Moyad Shahwan[a,*], Ammar Abdulrahman Jairoun[b], Mohammed Husham Khattab[a]

[a] College of Pharmacy and Health Sciences, Ajman University, Ajman, United Arab Emirates
[b] Consumer Product Safety Section, Public Health and Safety Department, Dubai Municipality, United Arab Emirates

ARTICLE INFO

Keywords:
Type 2 diabetes mellitus
Body mass index
Obesity
Calcium
Metformin

ABSTRACT

Background: Abdominal obesity is linked to many metabolic changes in type 2 diabetes.
Objective: The overall aim of this study is to determine the prevalence of obesity according to Body Mass Index (BMI) and the associated factors.
Methods: A cross-sectional study was carried out at private health care center. A total of 291 diabetic patients aged 18 years and above with type 2 diabetes mellitus who attended the clinic from May 2017 through February 2018 were included. Socio-demographic, clinical, and laboratory data were obtained from the medical records of patients. Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS, version 23). BMI was calculated as the weight in kilograms divided by height in meters squared (kg/m2). BMI was categorized into normal weight (< 25 kg/m2), Overweight (25–29.9 kg/m2) and Obese (≥ 30 kg/m2).
Results: A total number of 291 participated in the study. Among these participants 42.6% (n = 124) were male and 57.4% (n = 167) were female. The average age of respondents was 55.99 ± 9.81. In this study, 234 participants (80.4%) (95% CI: 75.8%–85%) were overweight/obese. The results of statistical modeling showed that age, smoking status, physical activity, taking Metformin and serum calcium are strong determinants of overweight/obesity.
Conclusion: Current study revealed significant association of overweight/obesity and serum calcium among patients with diabetes.

1. Introduction

Diabetes mellitus (DM) is one of the most complex and rapid growing diseases globally, affecting more than 415 million with estimated prevalence rate of 9% in adults around the world. About 90% of total diabetes cases can be accounted for type 2 diabetes. The international diabetes federation report predicts this number to increase, reaching up to 642 million by the year 2040. Due to the continuous rise in prevalence rate, diabetes has become as one of the major health threats globally (IDF Diabetes Atlas, 2015; World Health Organization, 2014). About 80% of these cases are in the developing countries (Islam et al., 2015).

In Palestine, the reported prevalence of type II diabetes in 2017 was found out to be 10.6% for the age group ranging from 20 to 79 years. However, studies estimate this percentage to be as high as 20.8% by 2020. Out of 1000 individuals, 169 were confirmed type II diabetic patients and is expected to be around as high as 489 by 2040 among the same number of population globally (IDF Diabetes Atlas, 2017; Abu-Rmeileh et al., 2013).

Diabetes comes in number six as the leading cause of deaths in Palestine, as 5.7% of total number of deaths are estimated to be caused by diabetes and its related complications (Abdo Sharif, Samara and Awartani, 2015).

Poor weight control and obesity has been shown to be a major modifying risk factor and strongly linked to type 2 diabetes as well as other morbidities such as increased risk of cardiovascular diseases and various types of cancer (Guh et al., 2009).

According to the World Health Organization report in 2014, overweight and obesity are becoming a public health issue for adults 18 years and older, where 39% was found overweight and 13% were obese, globally (World Health Organization, 2014).

Diabetes prevention can be achieved - in those who are obese and exhibiting high risk - if proper weight control is established. Moreover, weight control can be of extra benefits in individuals with established type 2 diabetes (Alia et al., 2013).

The World Health Organizations predicts a 2.8% reduction in

* Corresponding author.
E-mail address: moyad76@hotmail.com (M. Shahwan).

https://doi.org/10.1016/j.obmed.2019.100110
Received 11 April 2019; Received in revised form 23 May 2019; Accepted 28 May 2019

diabetes prevalence rate within 5 years if obesity is reduced by 5%. The prevalence can go as low as 20% within 10 years if obesity was to be reduced by 35% (Abu-Rmeileh et al., 2013).

Among different socioeconomic and age groups, obesity has been associated with an increased risk in the development of non-communicable diseases across both developed and developing countries (Musaiger, 2011).

. Furthermore, overweight and obesity among type 2 diabetic patients are linked with poor control of blood glucose, blood pressure and cholesterol level (Anderson et al., 2003). Across the middle eastern countries there has been a significant transition in the nutrition and life style (Popkin, 2002). In Palestine this fast-paced shifts in dietary intake is resulting in an increased prevalence rate of overweight and obesity. In one of the studies, the reported prevalence of overweight and obesity among Palestinian men and women was 71.3% for the latter and 58.7% for the former (Husseini et al., 2009).

Therefore, it is critical to study and asses the prevalence of obesity among type 2 Palestinian diabetic patients, to provide recent data for decision and policy makers to implement future strategies.

1.1. Subjects, materials and methods

This study had a cross sectional design was conducted in primary health care center in Ramallah district, Palestine. The participants were outpatients, consecutively recruited by specialist diabetes physician, at regular follow up visits during the period September 2017 through February 2018.The study was approved by ethics committee of the health center, and all the participants gave their informed consent. Relevant sociodemographic, clinical and laboratory data were obtained from the medical records of the patients including: age, gender, calcium level. Measurement of the last recorded serum vitamin D level was also considered in the study. This information was recorded on the data sheet. Anthropometric measurements were taken, including weight and height to estimate body mass index (BMI) [Kg/m2]. 'Overweight' is classified as having a BMI of 25.0–29.9, and obesity as having a BMI of ≥30 as defined by the WHO (World Health Organization, 2018).

1.2. Statistical analysis

Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS, version 23). Chi-square tests and multivariate logistic regression was used to assess the correlation between overweight/obesity and serum calcium among patients with diabetes and other related risk factors. Separate regression models were used, and stepwise method was used for variable selection and model building.

2. Results

2.1. Demographic and socio-economic characteristics

The demographic information of participants' is shown in Table 1. A total number of 291 participated in the study. Among these participants 42.6% (n = 124) were male and 57.4% (n = 167) were female. The average age of respondents was 55.99 ± 9.81. Regarding the age groups 25.4% (n = 74) aged between 28 and 51, 49.8% (n = 145) aged 52–62 and 24.7% (n = 72) aged > 62. Majority of the participants (74.2%) are married. Educational qualifications of the participants also varied. About 21% (n = 61) of the participants were Elementary school education holders, 44.3% (n = 129) were High school education holders and 34.7% (n = 101) were bachelor's degree holders.

2.2. Clinical and life style characteristics

The Clinical and life style information of participants are shown in Table 2. Average height of the participants was 165.17 ± 10.16. Average weight of the participants was 82.93 ± 49.98. Average body mass index of the participants was 30.51 ± 19.60. There was 57 (19.6%) normal weighted (< 25 kg/m2), 136 (46.7%) Overweight (25–29.9 kg/m2) and 98 (33.7%) were obese participants in the study. The Average serum calcium of the participants was 9.2 ± 0.5. The Average Serum Vitamin D of the participants was 19.5 ± 21. Of the total, 17.9% (n = 52) use Metformin and 4.1% (n = 12) takes Sulfonylurea.

Table 1
Frequency table for demographic and socio-economic characteristics of 291 Diabetic patients.

Frequency (Percentage)	Response	Demographic characteristics
Gender	Male	124 (42.6%)
	Female	167 (57.4%)
Age group	28–51	74 (25.4%)
	52–62	145 (49.8%)
	> 62	72 (24.7%)
Marital status	Single	75 (25.8%)
	Married	216 (74.2%)
Educational level	Elementary	61 (21%)
	High school	129 (44.3%)
	Bachelor's degree	101 (34.7%)

Table
2Descriptive statistics for Clinical &life style characteristics (n = 291).

Clinical &life style characteristics	Response	Frequency (Percentage)
Smoking status	Non-smoker	221 (75.9%)
	Smoker	70 (24.1%)
Physical activity	Yes	74 (25.4%)
	No	217 (74.6%)
Body Mass Index	Normal (< 25 kg/m2)	57 (19.6%)
	Overweight (25–29.9 kg/m2)	136 (46.7%)
	Obese (≥30 kg/m2)	98 (33.7%)
Taking Metformin	Yes	52 (17.9%)
	No	239 (82.1%)
Taking Sulfonylurea	Yes	12 (4.1%)
	No	279 (95.9%)
Age Mean ± S. D	55.99 ± 9.81	
Height – cm Mean ± S.D	165.17 ± 10.16	
Weight – kg Mean ± S. D	82.93 ± 49.98	
Body Mass Index – kg/m2 Mean ± S. D	30.51 ± 19.60	
Serum calcium mg/dl Mean ± S. D	9.2 ± 0.5 (reference value:8.5–10.2 mg/dl)	
Serum vitamin D ng/ml Mean ± S. D	19.5 ± 21 (reference value:20–50 ng/ml)	

2.3. Prevalence of overweight/obesity according to BMI

In this study, 234 participants (80.4%) (95% CI: 75.8%–85%) were overweight/obese.

Table 3 shows the prevalence of overweight/obese by demographic and socio-economic status. The table provides the estimates along with p-values. From the variables studied, the ones that presented a statistically significant relation the prevalence of overweight/obese were: gender (P = 0.001), marital status (P = 0.001), educational level (P = 0.002), smoking status (P = 0.02), physical activity (P = 0.011) and Metformin medication (P = 0.009). Regarding the calcium homeostasis, there was a significant association between the serum calcium and overweight/obesity with lower serum calcium for the overweight/obese participants (P < 0.001). For more details, comparing the two scores according to demographic and socio-economic factors see Table 3.

Table 3
Prevalence of overweight/obesity by demographic, clinical & life style characteristics.

\Demographic	Prevalence of overweight/obesity	
	Estimate	P.val
Gender		
Male	89 (71.8%)	0.001
Female	145 (86.8%)	
Age		
28–51	59 (79.7%)	0.914
52–62	118 (81.4%)	
> 62	57 (79.2%)	
Marital status		
Single	70 (93.3%)	0.001
Married	164 (75.9%)	
Educational level		
Elementary	56 (91.8%)	0.002
High school	107 (82.9%)	
Bachelor's degree	71 (70.3%)	
Smoking status		
Non smoker	171 (77.4%)	0.02
Smoker	63 (90%)	
Physical activity		
Yes	52 (70.3%)	0.011
No	182 (83.9%)	
Metformin		
Yes	35 (67.3%)	0.009
No	199 (83.3%)	
Sulfonylurea		
Yes	10 (83.3%)	0.795
No	224 (80.3%)	
Overweight/obesity	**Serum calcium**	< 0.001
No	9.65 ± 0.043	
Yes	9.12 ± 0.048	
	Serum vitamin D	0.073
No	23.92 ± 11.1	
Yes	18.37 ± 22.6	

2.4. Factors associated with overweight/obesity

Table 4 displays the results of binary logistic regression model applied to each demographic and socio-economic variable separately. This table shows the results for overweight/obesity. The odds ratios in this table shows the magnitude of the association and their corresponding p-values indicate whether the association is statistically significant or not by using the cut-off values of 0.05 as mentioned in the method section.

Table 4
Factors associated with overweight/obesity and abdominal obesity.

Demographic	Prevalence of overweight/obesity			
	OR		95% CI	P.val
Gender (Ref. Male)				
Female	2.59	1.43	4.69	0.002
Age (Ref. 28–51)				
52–62	1.11	0.55	2.25	0.77
> 62	0.97	0.43	2.16	0.93
Marital status (Ref. Married)				
Singles	4.44	1.70	11.59	0.002
Educational level (Ref. Bachelor)				
Elementary	4.73	1.73	12.99	0.003
High school	2.06	1.09	3.85	0.024
Smoking status (Ref. Non smoker)				
Smoker	2.63	1.13	6.11	0.024
Physical activity (Ref. Yes)				
No	2.2	1.19	4.07	0.012
Metformin use (Ref. No)				
Yes	0.81	0.21	0.41	0.010
Sulfonylurea use (Ref. No)				
Yes	1.23	0.26	5.76	0.79
Serum calcium	0.08	0.040	0.170	< 0.001
Serum Vitamin D	0.99	0.98	1	0.12

Table 5
Multiple logistic regression model (Stepwise procedure) for overweight/obesity.

Independent variables	overweight/obesity					
	B	S. E	OR	95% CI		P.val
Aged 28–51 age	0.73	0.53	2.08	0.74	5.84	0.166
Aged 52-62	1.86	0.52	6.41	2.31	17.83	0.000
Smoking status (yes)	1.79	0.49	6.01	2.29	15.69	0.000
Physical activity (yes)	−1.55	0.43	0.21	0.09	0.49	0.000
Metformin use (yes)	−0.89	0.45	0.41	0.17	0.9	0.050
Serum Calcium	−2.61	0.42	0.074	0.03	0.17	0.000

In the present study, significantly increased risk of overweight/obesity were observed in female gender (OR 2.59; 95% CI 1.43–4.69), being Unmarried (OR 4.44; 95% CI 1.70–11.59), Elementary education holders (OR 4.73; 95% CI 1.73–12.99), higher education holders (OR 2.06; 95% CI 1.09–3.85), smokers (OR 2.63; 95% CI 1.13–6.11) and non-active physically (OR 2.2; 95% CI 1.19–4.07). However, significantly decreased risk of overweight/obesity was observed Metformin users (OR 0.41; 95% CI 0.21–0.81).

Moreover, overweight/obese subjects were more likely to have lower serum calcium OR (0.08; 95% CI 0.040–0.170).

To select the set of factors that jointly influence the overweight/obesity, we used the stepwise procedure applied to the multiple logistic regression model. The results of this procedure showed that age, smoking status, physical activity, taking Metformin and serum calcium are jointly highly associated with overweight/obesity. For more details see Table 5.

3. Discussion

The results of current study reveals that age, smoking status, physical activity, taking Metformin and serum calcium are strong determinants of overweight/obesity.

Moreover, Current study showed a high prevalence of overweight/obesity among patients with Diabetes Mellitus which may endanger their life and increase the risk of metabolic complications that are associated with overweight/obesity. The results indicated that there was a significant association between the serum calcium and overweight/obesity with lower serum calcium for the overweight/obese participants (P < 0.001).

There is wide range of data evaluating the association of age, smoking status, physical activity, taking Metformin and serum calcium with overweight/obesity (Kim et al., 2016; Ren et al., 2013; Lentferink et al., 2018; Levri et al., 2005).

Although some have reported conflicting results with respect to these parameters. For instance, when the effect of metformin was investigated in 2 placebo-controlled studies, the results showed no significant weight loss when compared to the placebo groups (Fontbonne et al., 2009; Shahwanet al., 2019).

However, several other studies illustrated that metformin lowers the calories intake in obese patients with type 2 diabetes, hence leading to the reduction in the weight (Lee and Morley, 1998; Marques et al., 2017; Seifarth et al., 2012).

Similarly, in this study it was also found that there is significant decreased risk of overweight/obesity among Metformin users. About association of serum calcium level with overweight/obesity, we found that overweight/obese subjects were more likely to have lower serum calcium. In line with present data, in a study on 908 subjects, the obese individuals were observed to have lower serum calcium levels (Jafari-Giv et al., 2019).

Although some studies reported that there is no significant

association between smoking and increased obesity (Kim et al., 2016). Our study is in agreement with other findings where the association between the obesity and smoking was found to be significantly high compared with non-smokers (Moayad et al., 2018; Canoy et al., 2005).

The major strength of the current study included enrolling a population-based sample including both male and female participants. There is also a limitation: Given the cross sectional prospective design, our study is need to include wider range of population in order to enable the impact of overweight and obesity to be estimated in terms of their Population based risk, which can help policy makers determine strategies for diabetes control in Palestine, furthermore there was a lack of collection of other potential risk factors such as the dietary habits, life style and other comorbidities.

In conclusion, we suggest that BMI is associated with serum calcium, indicating the obese subjects had a lower level of calcium. Further investigations are recommended to explore the clinical impact of biochemical parameters and hematological factors on serum calcium level with respect to diabetes mellitus.

4. Conclusion

This is a cross sectional study to estimate the prevalence of obesity according to Body Mass Index and the associated factors in patients with type 2 diabetes mellitus attending a private health care center in Palestine. The present study showed:

- The high prevalence of overweight/obesity observed in Palestinian patients diagnosed with type 2 diabetes mellitus.
- Overweight/obese is significantly associated with lower serum calcium levels.

The high prevalence of overweight/obesity obtained in the study supports the need to promote and implement the utilization of obesity and diabetes screening at the national level.

Conflicts of interest statement

No potential conflict of interest relevant to this article was reported.

References

Abdo Sharif, N., Samara, I., Awartani, A., 2015. Compliance With and Knowledge About Diabetes Guidelines Among Physicians and Nurses in Palestine International Study for Asthma and Allergy in Childhood View project Diabetes in Palestine View Project. https://doi.org/10.26719/2015.21.11.791.

Abu-Rmeileh, N.M.E., et al., 2013. 'Preventing type 2 diabetes among Palestinians: comparing five future policy scenarios', *BMJ Open*. Br. Med. J. Publ. Group 3 (12), e003558. https://doi.org/10.1136/BMJOPEN-2013-003558.

Alia, Dareen, Abduelkarema, Abduelmula, Shahwan, Moyad, Shahwan, Monzer, 2013. Evaluation of factors associated with inadequate glycemic control and some other health care indicators among patients with type 2 diabetes in Ramallah, Palestine. Res. J. Pharmaceut. Biol. Chem. Sci. 4 (3), 445–451.

Anderson, J.W., Kendall, C.W.C., Jenkins, D.J.A., 2003. Importance of weight management in type 2 diabetes: review with meta-analysis of clinical studies. J. Am. Coll. Nutrit. Routledge 22 (5), 331–339. https://doi.org/10.1080/07315724.2003.10719316.

Canoy, D., et al., 2005. Cigarette smoking and fat distribution in 21, 828 British men and women: a population-based study. Obes. Res. 13 (8), 1466–1475. https://doi.org/10.1038/oby.2005.177. John Wiley & Sons, Ltd.

Fontbonne, A., et al., 2009. Effects of 1-year treatment with metformin on metabolic and cardiovascular risk factors in non-diabetic upper-body obese subjects with mild glucose anomalies: a post-hoc analysis of the BIGPRO1 trial. Diabetes Metabol. 35 (5), 385–391. https://doi.org/10.1016/J.DIABET.2009.03.005. Elsevier Masson.

Guh, D.P., et al., 2009. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Publ. Health 9 (1), 88. https://doi.org/10.1186/1471-2458-9-88. BioMed Central.

Husseini, A., et al., 2009. Cardiovascular diseases, diabetes mellitus, and cancer in the Occupied Palestinian Territory. Lancet 373 (9668), 1041–1049. https://doi.org/10.1016/S0140-6736(09)60109-4. Elsevier.

International Diabetes Federation, 2015. IDF Atlas, seventh ed. . https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/13-diabetes-atlas-seventh-edition.html.

International Diabetes Federation, 2017. Diabetes Atlas, eighth ed. .

Islam, S.M.S., et al., 2015. Clinical characteristics and complications of patients with type 2 diabetes attending an urban hospital in Bangladesh. Diabetes Metabol. Syndr. Clin. Res. Rev. 9 (1), 7–13. https://doi.org/10.1016/J.DSX.2014.09.014. Elsevier.

Jafari-Giv, Z., et al., 2019. Association of body mass index with serum calcium and phosphate levels. Diabetes Metab. Syndr. Clin. Res. Rev. 13 (2), 975–980. https://doi.org/10.1016/J.DSX.2018.12.017. Elsevier.

Kim, Y., et al., 2016. 'Associations of smoking with overall obesity, and central obesity: a cross-sectional study from the Korea National Health and Nutrition Examination Survey (2010-2013. Epidemiol. Health. Korean Soc. Epidemiol. 38, e2016020. https://doi.org/10.4178/epih.e2016020.

Lee, A., Morley, J.E., 1998. Metformin decreases food consumption and induces weight loss in subjects with obesity with type II non-insulin-dependent diabetes. Obes. Res. 6 (1), 47–53. https://doi.org/10.1002/j.1550-8528.1998.tb00314.x. John Wiley & Sons, Ltd.

Lentferink, Y.E., et al., 2018. Long-term metformin treatment in adolescents with obesity and insulin resistance, results of an open label extension study. Nutrition Diabetes 8 (1), 47. https://doi.org/10.1038/s41387-018-0057-6. Nature Publishing Group.

Levri, K.M., et al., 2005. 'Metformin as treatment for overweight and obese adults: a systematic review.', *Annals of family medicine*. Am. Acad. Fam. Phys. 3 (5), 457–461. https://doi.org/10.1370/afm.343.

Marques, P., et al., 2017. Metformin effectiveness and safety in the management of overweight/obese nondiabetic children and adolescents: metabolic benefits of the continuous exposure to metformin at 12 and 24 months. Int. J. Adolesc. Med. Health 29 (5). https://doi.org/10.1515/ijamh-2015-0110. De Gruyter.

Moayad, S., Nageeb, H., Adel, N., Naheed, B., 2018. Prevalence and risk factors of vitamin B_{12} deficiency among patients with type II diabetes on metformin: a study from Northern region of United Arab Emirates. Asian J. Pharmaceut. Clin. Res. (8), 225–229 Apr.

Musaiger, A.O., 2011. Overweight and obesity in eastern Mediterranean region: prevalence and possible causes. J. Obes. 2011 (January 1990), 1–17. https://doi.org/10.1155/2011/407237.

Popkin, B.M., 2002. Part II. What is unique about the experience in lower-and middle-income less-industrialised countries compared with the very-highincome industrialised countries? Publ. Health Nutr. 5 (1a), 205–214. https://doi.org/10.1079/PHN2001295. Cambridge University Press.

Ren, X., et al., 2013. Overweight and obesity associated with increased total serum calcium level: comparison of cross-sectional data in the health screening for teaching faculty. Biol. Trace Elem. Res. 156 (1–3), 74–78. https://doi.org/10.1007/s12011-013-9856-8. Springer US.

Seifarth, C., Schehler, B., Schneider, H., 2012. Effectiveness of metformin on weight loss in non-diabetic individuals with obesity', experimental and clinical endocrinology & diabetes. J. A. Barth Verlag in Georg Thieme Verlag KG 121 (01), 27–31. https://doi.org/10.1055/s-0032-1327734.

Shahwan, M.J., Gacem, S.A., Zaidi, S.K., 2019 Feb 14. Prevalence of Diabetic Nephropathy and associated risk factors among type 2 diabetes mellitus patients in Ramallah, Palestine. Diabetes Metab. Syndr. Clin. Res. Rev. 13 (2), 1491–1496. https://doi.org/10.1016/j.dsx.2019.02.017.

WHO key facts, 2018. Diabetes. https://www.who.int/news-room/fact-sheets/detail/diabetes.

World Health Organization, 2014. Global Status Report on Noncommunicable Diseases. . http://www.who.int/nmh/publications/ncd-status-report-2014/en/.