PREVALENCE OF OBESITY IN DIABETIC FEMALES OF MARDAN KP PAKISTAN

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Abstract

Being overweight or obese increases the chances of developing the common type of diabetes, type 2 diabetes mellitus. The aim of current study was to investigate the relation between diabetes in (female) patients with prevalence of obesity and their nutritional status. A total of 200 samples were collected randomly from January 2021 to March 2021, which consisted of women of age 25 to 50 years Anthropometric parameter including height, weight, waist and hip ratio, body fat and BMI was measured by standard procedures. Dietary data of the subject was collected by using specially developed questionnaire. Random self-reported diabetes test was noted and health status of the patients was assessed through specific questionnaire however other relevant information was collected through personal interview. All data was analyzed through SPSS (SPSS Inc.2007). Initial descriptive statistics was carried out to check the data for error. The mean weight and height of the participants were recorded as 82 kg and 151.9 cm respectively. The mean BMI of the respondents was 34.1 with standard deviation of 6.3, whereas, the recorded mean ideal body weight was 55.53 with standard deviation of 3.5. The mean body fats were 45.3 with the mean waist to hip ratio of 1.2. The study concluded that participants' (83%) were severely obese followed by (9.5%) overweight. The mean blood glucose level was recorded as 274.5 with standard deviation of 97.5. A significant difference ($p<0.05$) was seen for difference types of disease and obesity whereas a non-significant difference for use of medication and family history. A significant effect ($p<0.05$) for five serving of fruits and vegetables, fast food intake, having diet plan, eaten large amount of food, hunger sensation and exercise whereas a non-significant difference ($p>0.05$) for dieting, sleep duration and water intake in relation to body.

Introduction Obesity is defined as a state of health in which abnormal or excessive body fat accumulates to a detrimental level. The body mass index (BMI), a measure

obtained by dividing a person's weight by a person's square height, is in the range of 25-30 kg / m2 despite the algometric subtraction of excess weight. And those usually over 30 kg / m2 are considered obese (WHO, 2020; Das *et al.*,2021). Various diseases and conditions, especially cardiovascular disease, obstructive splenic apnea, type 2 diabetes mellitus, osteoarthritis and certain types of cancer are associated with obesity (Janine *et al.*, 2020). High BMI is considered a risk factor for foodborne illness, exercise and environmental factors, although it has not been shown to be a direct cause (Excerpt., 2018).

Obesity includes personal, social, economic and environmental factors, including diet, exercise, industrial growth, modernization, genetic sensitivity, drugs, mental retardation, economic policies, and endocrine disorders (WHO, 2020; YzDift, 2015). Studies have shown that while most obese people try to lose weight over a period of time and are often successful, long-term management of weight loss is rare. An increase in appetite during and after calorie restrictions is the cause of cycling, which is not fully understood by many and leads to obesity. More studies are needed to determine whether weight gain and dieting of yo-yo contribute to the risk of inflammation and disease like diabetes in obese people (Chooi *et al*., 2019).

Preventing obesity requires a complex process that involves interventions at the individual, family and community level (Chiolero*et al*., 2018). Physical activity and changes in diet are major health measures recommended by health professionals (Janine *et al.*, 2015). However, large-scale analysis has found a negative relationship between energy consumption in developing countries and energy consumption in developed countries (Tester *et al*., 2020). Nutrition is not available when "food deserts" or "food swamps" are considered geographical and may be occupied by low-income people (Susan. 2015). Absorption drugs can be used in combination with foods that should reduce or decrease appetite (Yanovsky. 2015). Installation of balloons or surgery can reduce the size of the abdomen or the length of the intestines, allowing nutrients to be quickly changed or removed from the diet when diet, exercise, and medication do not work. (Hemant *et al.*, 2021).

Obesity is linked to type 2 diabetes, heart disease and other cancers. The prevalence of

these diseases is highest in middle-income countries in Eastern Europe, Latin America, and Asia, where obesity is the fifth most common cause of weight gain. The high risk of obesity-related diabetes and heart disease in Asians may be due to the tendency to deal with obesity, which can lead to metabolic syndrome disorders and glucose tolerance disorders. The increase in type 2 diabetes is closely related to the increase in obesity. About 90% of type 2 diabetes is caused by obesity. In addition, about 197 million people worldwide have glucose intolerance, often as a result of obesity and metabolic syndrome. This number is expected to increase to 420 million by 2025. Studies conducted in 75 communities in 32 countries show that diabetes is rare in developing countries where traditional lifestyles are maintained. In contrast, other Arab, Chinese, and Spanish communities which has mingled with Western nations has increased their risk of developing diabetes and obesity to greater extent. In this population, the incidence of diabetes is between 14 and 20%. In addition, population growth in developing countries is particularly prevalent in urban areas (Rudrapal*et al*., 2021).

Type 2 diabetes mellitus (T2DM), formerly known as chronic diabetes, is a type of diabetes characterized by high blood sugar, insulin resistance, and insulin deficiency. Common symptoms include increased thirst, frequent urination, and unexplained weight loss. Symptoms may include increased appetite, fatigue and ulcers. Symptoms usually appear gradually (National intellectual disability database; NIDD, 2019). Chronic problems with high blood sugar can lead to recurrent heart disease, diabetes, which can lead to blindness, kidney failure, and paralysis of blood vessels (WHO. 2020). Hyperosmolar hyperglycemic conditions can occur spontaneously; however, ketoacidosis is rare (American diabetes association; ADA, 2021; Derak*et al.*, 2019).

Type 2 diabetes is caused by obesity and a lack of exercise (WHO, 2020). Some people are more vulnerable to genetic predisposition than others (NIDD, 2019). 90% of diabetes cases are due to type 2 diabetes, the remaining 10% are mainly caused by type 1 diabetes and gestational diabetes (WHO, 2020). Automatic damage to beta-insulating beta cells linked to type 2 diabetes mellitus lowers total insulin levels to control blood sugar (Al-Mrabeh*et al.*,

2020; Antonetti*et al.*, 2021). Diabetes can be diagnosed by blood tests such as plasma glucose, glucose tolerance tests or glycated hemoglobin; A1c (NIDD, 2019).

The global prevalence of obesity is approaching epidemic proportions. The WHO estimates that over 1.9 billion adults (39%) were overweight worldwide in 2016 and that more than 650 million (13%) were overweight (WHO, 2020). In addition, researchers from the Non-Communicable Diseases Risk Factor Collaboration reported an increase in obesity rates in each country between 1975 and 2016; the highest growth was recorded in South Asia, Southeast Asia, the Caribbean and South Latin America (Bentham *et al.*, 2017). Current acceleration of growth by 2030 half the world's population will be overweight or obese (Hulsegge*et al.*, 2021).

Obesity is a growing problem for adults and children, especially in Western lands. A WHO report shows that obesity has doubled since 1980 and 2014, with more than 1.9 billion adults, 18 years of age and older, being overweight. Of these, more than 600 million were obese, with an additional 18% and 39% obese in 2014; with 13% overweight (WHO, 2017). As in other countries, obesity is on the rise in Pakistan. According to a study, WHO found that about 26% of Pakistani women had side effects; while only 19% were overweight men. In 2013, the average was 28 for every male pen and 38 for every female pen, which is a huge gap between the two sexes. In contrast to regional areas, urban areas accounted for 56% more men and 67% more women. In fact, obesity is also rapidly increasing during adolescence. According to 2013 data it is 10%, which is an amazing number. According to the Express Tribune, Pakistan ranks ninth in obesity among 188 countries by race (Obesity in Pakistan 2017). According to the WHO Asia Pacific cutoff, the prevalence of obesity is 57.9% (42% for men and 58% for women) and moderate obesity is 73.1% (37.3% for men and 62.7% for women). Obesity is at its highest in Punjab by 60%, followed by Khyber Pakhtunkhwa by 59.2%. In addition, Baluchistan has the highest incidence of abdominal obesity at 82.1%, followed by Punjab at 73.3% (Basit et al., 2017).

About 463 million adults 20-79 years old; are living with diabetes, which is expected to rise to 700 million by 2045. The number of people with type 2 diabetes is increasing in many countries, with 79% of adults living with diabetes. In low- and middle-income countries, 1 in 5 people over the age of 65 has diabetes. One in two people (232 million) with diabetes is undiagnosed. Diabetes has killed 4.2 million people.

Diabetes will generate at least $ 760 billion in health care costs by 2019 - 10% of adult spending. More than 1.1 million children and adolescents are living with type 1 diabetes. More than 20 million births (one of six births) are associated with gestational diabetes. About 374 million people are at risk of developing type 2 diabetes (international diabetes federation; IDF, 2019).

The current prevalence of type 2 diabetes mellitus in Pakistan is 11.77%. The prevalence was 11.20% for males and 9.19% for females. The average growth rate in Sindh province is 16.2% for men and 11.70% for women; In the Punjab province it is 12.14% for men and 9.83% for women. Baluchistan Province has 13.3% males and 8.9% females; In Khyber Pakhtunkhwa (KPK) it is 9.2% for men and 11.60% for women. The prevalence of type 2 diabetes is 14.81% in urban areas and 10.34% in rural Pakistan. The prevalence of type 2 diabetes in Pakistan is 11.77%. It is more common in men than in women and is more common in cities than in rural areas. Pakistan should incorporate diabetes prevention measures into national health policy to reduce the burden of disease (Adnan *et al*., 2020).

OBJECTIVES

To assess the knowledge and incidence of obesity among female patients suffering from type 2 diabetes mellitus.To evaluate the relationship between the onset of obesity and outcome of type 2 diabetes mellitus.

Methodology

It was a cross sectional study that was conducted at Mardan Medical Complex and Dar-ul-Shifa located in district Mardan.A total of 100 samples were collected randomly from January 2021 to March 2021 that consisted of women of age 25 to 50 years who had already visited 2 to 3 times to hospital and already diagnosed for diabetes.

Data collection

A pre-planned questionnaire was developed to collect the data regarding socio-demographic status of women by interviewing women about their general data e.g. age, education, clinical manifestations, physical activity, marital status and family history etc. and socio economic data.Anthropometric parameter including height, weight, waist and hip ratio, body fat and BMI were measured by standard procedures.Dietary data of the subject was collected by using specially developed questionnaire. Random Self-reported diabetes test was noted and health status of

subjects was assessed through specific questionnaire however other relevant information was collected through personal interview.

The entire data was recorded in SPSS (Statistical package for Social Sciences) Version 22. Descriptive statistics was applied to find out the frequencies of variables whereas independent test was applied to calculate the means of variables.

RESULTS

Socio demographic data

The socio demographic characteristics of the subjects. The mean age of the respondents was 40.1 with standard deviation of 7.9. Most (90.5%) of the women were married and some were single (9.5%). The participants (43.0%) had primary education followed by secondary education (27.0%) and Intermediate (19.5%). Joint family system was found for 56.5%, most of the fathers/husband were government servant (38.5%).

Anthropometric characteristics

Table Anthropometric characteristics

Variables	Mean	Std. Deviation
Weight	82	16.57569
Height	151.9	13
BMI	34.1	6.28997
IBW	55.53	3.51004
Body fats	45.3	6.4
WTH	1.2	3.62624

The percentages of the body mass index (BMI) shows in figure 4.

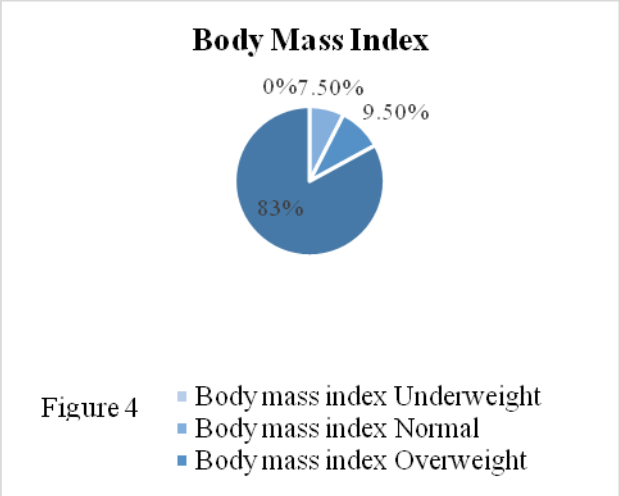


Figure 4

Health history

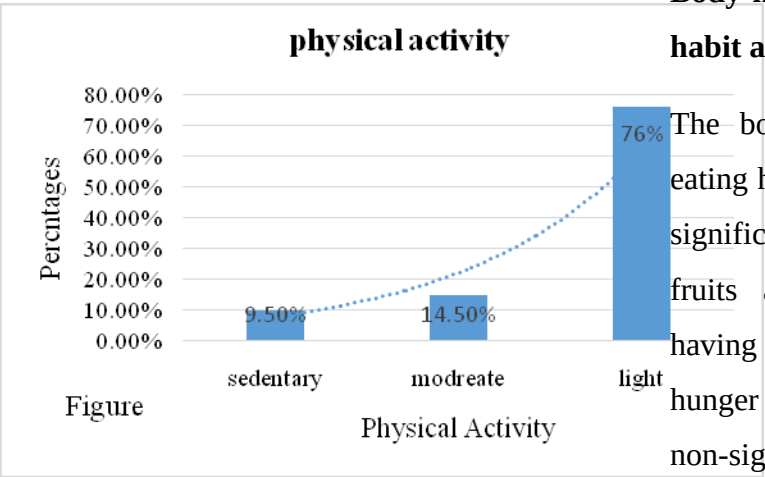
It shows the health history of the subjects. The Mean Blood Glucose level was recorded as 274.5 with standard deviation of 97.5. The mean age of diabetes was 35.7 years with S.D of 7.7. Patients (53.0%) had high blood pressure followed by other disease (15.5%) and high cholesterol (15.0%). women (99.0%) were taking medicine, where (53.0%) did not had any family history of diabetes. Diabetic patients (35.5%) were using medicine from 1-3

years, where most of the respondents (52.5%) were diagnosed with diabetes after the age of 40.

Eating and diet history

The eating habit and dietary history of women that are obese and diabetic. Only (39.5%) of them were having 5 portion of fruits. It is recorded that (41.5%) took fast food occasionally. Majority (87.5%) were not having any diet plan. women (61.0%) were dieting without adequate knowledge. participants (65.0%) had large amount of foods. where (33.5%) had sleep duration from 5 to 6 hours. most food consumed by the patients was rice (27%) followed by fatty and oily food (20.0%), pulses (19.0%) and milk products (18.5%). Most of them (61.0%) had 3 to 4 time of meal in a day.

Figure 6 shows the percentages of physical activity of the subjects.



Figure

Figure 7 shows percentages of the daily water intake of the subjects.

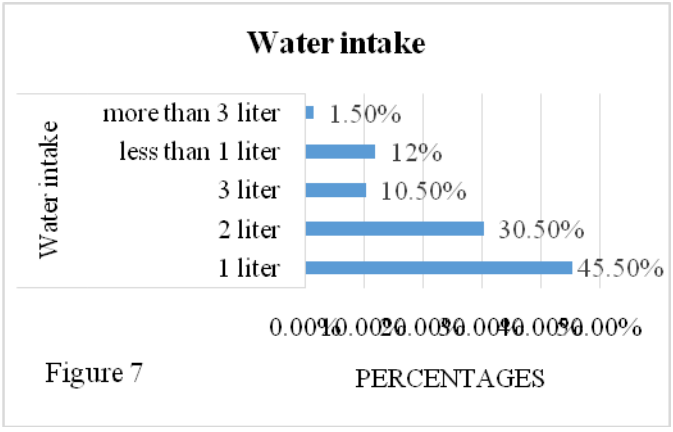


Figure 7

Body mass index in relation to the health status

The body mass index in relation to the health status of the patients is illustrated. A significant difference ($p<0.05$) was seen for difference types of disease and obesity whereas a non-significant difference for use of medication and family history.

Body mass index in relation to the eating habit and diet history

The body mass index in relation to the eating habit and diet history is elaborated. A significant effect ($p<0.05$) for five serving of fruits and vegetables, fast food intake, having diet plan, eaten large amount of food, hunger sensation and exercise whereas a non-significant difference ($p>0.05$) for dieting, sleep duration and water intake in relation to body mass index was observed.

DISCUSSION

Socio demographic characteristics

The study concluded that the mean age of the participants was 40.1 with standard deviation of 7.9. Most (90.5%) of the women were married and some were single (9.5%). Participants (43%) had primary education followed by secondary education (27.0%) and intermediate (19.5%). Joint family system was found for 56.5%. Most of the fathers/husband were government servant (38.5%). These finding of the study resembles to the work of (Leoone*et al*., 2020; Ke*et al*., 2021) Examined the dietary habits of type II diabetics living in refugee camps in Algeria; the sample consisted of 65 diabetic women from six households in two separate households. Average age of 58 (25th-75th: 52-64 years). About 58.5% of women were married. In all, women lived in houses ranging from 6 (25-75: 5-8) to the 16th. Education levels were generally low - 38.5% of women had no education, and only 27.7% had basic education, only 3.1% of women had a degree. Eventually, half of the women employed were employed, and the remaining 50% were housewives or retired.

Anthropometric characteristics

The study concluded that the mean weight of the women was 82 kg with standard deviation of 16.5. The mean height was 151.9 cm with standard deviation of 15.0. The mean BMI of the was 34.1 with standard deviation of 6.2. The mean ideal body weight was 55.53 with standard deviation of 3.5. Where the mean body fats were 45.3 with standard deviation of 6.4. And the mean waist to hip ratio was 1.2 respectively furthermore the study concluded that patients (83.0%) were severely obese followed by overweight (9.5%) a Normal (7.5%). This finding of the correlates with the work of (leone*et al*., 2020) (Gozalbo*et al*., 2020) (Roser*et al.*, 2020) who Examine the dietary habits of type II diabetics/ overweight women. The sample consisted of 65 diabetic women from six households in two separate households. The study ended with an average weight of 71.7 kg and an average length of 157 cm, with an average BMI of 28.7 kg / m2 (25th - 75th: 25.6-31.8 kg / m2). Using the NIH (national institute of health) criteria determined for normal obesity, 20.0% of women were overweight, 35.4% were overweight, and 44.6% were obese, with obesity in the second stage (6.2%). Also included is one woman (1.5). Added. %) For third stage obesity. Total body, median

value of more than 45.4% (25 - 75th: 43.7-47.3%), and more than 30% of all women. In terms of abdominal obesity, all women have a high waist circumference, and 58.5% have WHR 1.

Health history of female diabetic patient

The study concluded that the Mean Blood Glucose level was recorded as 274.5 with standard deviation of 97.5. The mean age of diabetic patients was 35.7 years with S.D of 7.7. They also (53.0%) had high blood pressure followed by other disease (15.5%) and high cholesterol (15.0%). Reported women (99.0%) were taking medicine. patients ((53.0%) did not had any family history of diabetes. (35.5%) were using medicine from 1-3 years. These findings of the study resemble to the work of (Kassahun*et al*., 2016; Elizabeth C *et al.*, 2021) who It researches the family history of diabetes, obesity, risk awareness, knowledge and health behavior. The burden of type 2 diabetes affects people unequally. For example, according to nationally representative sample data, half to one-fifth of white men have more diabetes or diabetes than African American men, and almost twice as many African American women than white women. It is possible. It is estimated that 33% to 50% of people with type 2 diabetes are diagnosed. As a result, many patients may experience initial symptoms of the disease during their clinical diagnosis. In addition to age and obesity, family history has a well-known risk factor for type 2 diabetes, with a risk rating of 2 to 6 depending on the study design and case description. Family history reflects both cultural factors such as preferences, values and beliefs, as well as inherited and shared genetic sensitivity, including behavioral factors such as diet and physical activity. Therefore, a family history of diabetes can be a useful tool for identifying people at risk for the disease and identifying behavioral changes that can delay the onset of the disease and improve health outcomes.

Dietary history of female diabetic patient.

The study concluded that only (39.5%) had 5 portion of fruits. (41.5%) took fast food occasionally. Where (87.5%) were not using any diet plan. (61%) patients were dieting with almost no knowledge which may be the path to the onset of obesity and diabetes. women (65%) had large amount of foods at once rapidly because (33.5%) had hunger sensation. Most food consumed was rice (27%) followed by fatty and oily food (20.0%), pulses (19.0%) and milk products (18.5%). Most of them (61.0%) had 3 to 4

time of meal in a day. This outcome of the study resembles to the work of (Ford *et al.*, 2019) A group of 25-74 year olds in the U.S. who followed for nearly 20 years examined whether diabetes was associated with fruit and vegetable consumption. Of the 9,665 participants in the analytical sample, 1,018 developed diabetes mellitus. The percentage of participants who ate five or more fruits and vegetables per day was lower than the average intake of fruits and vegetables (p <0.001). After adjusting for age, race or ethnicity, cigarette smoking, systolic blood pressure, antihypertensive use, serum cholesterol concentration, body mass index, recreational exercise, recreational exercise and alcohol consumption, participants consume five or more servings of 0.77 servings per day. % Confidence interval (CI), 0.54-0.98) for all participants, 0.54 (95% CI, 0.36-0.81) and 1.09 (95% CI) for women. 0.63-1.87) for males. Adding education to the model put the risk at 0.79 (95% CI, 0.59-1.06) for all participants, 0.61 (95% CI, 0.42-0.88) for women and 1.14 (95% CI, 0.67-1.93) for men. The ratio was done Changed (Mehrabian F *et al*.,2018; Buzzano et al., 2018) Examine the association between fruit, vegetable and fruit juice intake and the development of type 2 diabetes. In 1984, a total of 71,346 female nurses aged 38–63 years without heart disease, cancer and diabetes were followed for 18 years and dietary data were collected every 4 years. Diagnosis of diabetes is self-reported. During the follow-up, 4,529 cases of diabetes were reported and the cumulative incidence of diabetes was 7.4%. A three-servings / day increase in total fruit and vegetable consumption was not associated with the development of diabetes (multivariate-adjusted risk ratio 0.99 [95% CI 0.94–1.05]), but overall fruit consumption was associated with lower diabetes. Risk (0.82 [0.72–0.94]). A 1 1 day / day increase in the consumption of green leafy vegetables is associated with a moderately reduced risk of diabetes (0.91 [0.84–0.98]), while a similar change in fruit juice intake is associated with an increased risk of diabetes (1.18 [1.10]).) -1.26]).

CONCLUSIONS

The study concluded that most of the subjects were severely obese followed by overweight and Normal. The Mean Blood Glucose level was highly elevated. Majority of the subject were having high blood pressure followed by other disease and high cholesterol. All of the enrolled Subjects were taking medicine. Some of the Subjects did not had any family history of diabetes.

Some of the subject has 5 portion of fruits. Fast food was consumed occasionally. Most of the Subjects were not having any diet plan. Most of the Subjects had light Physical activity. A significant effect was seen for difference types of disease, obesity, five serving of fruits and vegetables, fast food intake, having diet plan, eaten large amount of food, hunger sensation and Exercise whereas a non-significant difference for use of medication, family history of disease, Dieting, sleep duration and water intake in relationship with the body mass index (BMI)

RECOMMENDATIONS

Some of the below recommendation are proposed on the basis of current research study

Keeping a healthy body weight is equally important for each and every individual, Sleep duration must be maintained from 6 to 8 hour hours in a day. Take an exercise of normal walk up from 30 to 45 minutes' daily. Water intake should be increased. Nutrient dense food should be preferred instead of energy and caloric dense food, Carbohydrate intake should be decreased and too much stress must be avoided. Furthermore, research study must be conducted to evaluate other risk factors of obesity and diabetes. Community based orientation and campaigns should be launched and carried out to spread awareness.

REFERENCES

"Long-term drug treatment for obesity: A systematic and clinical review". (2014, January). Retrieved September 02, 2021, from https://europepmc.org/articles/PMC3928674

Adnan, M., &Aasim, M. (2020). Prevalence of type 2 diabetes mellitus in adult population of pakistan: A meta-analysis of prospective cross-sectional surveys. *Annals of Global Health*, *86*(1). https://doi.org/10.5334/aogh.2679

Al-Mrabeh, A., Zhyzhneuskaya, S. V., Peters, C., Barnes, A. C., Melhem, S., Jesuthasan, A., Aribisala, B., Hollingsworth, K. G., Lietz, G., Mathers, J. C., Sattar, N., Lean, M. E. J., & Taylor, R. (2020). Hepatic lipoprotein export and remission of human type 2 diabetes after weight loss. *Cell Metabolism*, *31*(2). https://doi.org/10.1016/j.cmet.2019.11.018

Antonetti, D. A., Silva, P. S., & Stitt, A. W. (2021). Current understanding of the molecular and cellular pathology of diabetic retinopathy. *Nature Reviews*

Endocrinology,17(4), 195-206. doi:10.1038/s41574-020-00451-4

Appel, I. (2013). Limitations of risk law. *Climate Change: International Law and Global Governance*, 867-899. doi:10.5771/9783845242781-867

Basit, A., Askari, S., Zafar, J., Riaz, M., &Fawwad, A. (2021). NDSP 06: Prevalence and risk factors for obesity in urban and rural areas OF Pakistan: A study from second national DIABETES survey of Pakistan (ndsp), 2016–2017. *Obesity Research & Clinical Practice,15*(1), 19-25. doi: 10.1016/j.orcp.2020.11.007

Das, B., Das, M., Kalita, A., &Baro, M. R. (2021). The role of Want pathway in obesity INDUCED inflammation and DIABETES: A review. *Journal of Diabetes & Metabolic Disorders*. doi:10.1007/s40200-021-00862-8

Diabetes care in the Hospital: Standards of medical care in Diabetes—2021. (2020). *Diabetes Care,44*(Supplement 1). doi:10.2337/dc21-s015

Endocrine-disrupting chemicals: *Economic, regulatory, and policy implications*. (n.d.). Retrieved September 01, 2021, from https://read.qxmd.com/read/32707119/endocrine-disrupting-chemicals-economic-regulatory-and-policy-implications

Goyal, H., Kopel, J., Perisetti, A., Mann, R., Ali, A., Tharian, B., . . . Inamdar, S. (2021). Endobariatric procedures for obesity: Clinical indications and available options. *Therapeutic Advances in Gastrointestinal Endoscopy,14*, 263177452098462. doi:10.1177/2631774520984627

Gozalbo, M., Guillen, M., Taroncher-Ferrer, S., Cifre, S., Carmena, D., Soriano, J. M., &Trelis, M. (2020). Assessment of the nutritional status, diet and intestinal parasites in hosted saharawi children. *Children,7*(12), 264. doi:10.3390/children7120264

Hossain, P., Kawar, B., & El Nahas, M. (2007). Obesity and diabetes in the developing world — a growing challenge. *New England Journal of Medicine,356*(3), 213-215. doi:10.1056/nejmp068177

Hulsegge, G., Proper, K. I., Loef, B., Paagman, H., Anema, J. R., & Van Mechelen, W. (2021). The mediating role of lifestyle in the relationship between shift work, obesity and diabetes. *International Archives of Occupational and Environmental Health*. doi:10.1007/s00420-021-01662-6

Kakoly, N. S., Khomami, M. B., Joham, A. E., Cooray, S. D., Misso, M. L., Norman, R.

J., . . . Moran, L. J. (2018). Ethnicity, obesity and the prevalence of impaired glucose tolerance and type 2 diabetes in PCOS: A systematic review and meta-regression. *Human Reproduction Update,24*(4), 455-467. doi:10.1093/humupd/dmy007

Kassahun, T., Gesesew, H., Mwanri, L., &Eshetie, T. (2016). Diabetes related knowledge, Self-care behaviours and adherence to MEDICATIONS Among diabetic patients in Southwest ETHIOPIA: A cross-sectional survey. *BMC Endocrine Disorders,16*(1). doi:10.1186/s12902-016-0114-x

Ke, Z., & Tong, W. (2021). Response to comment on: The use of VISCERAL Adiposity index to Predict Diabetes remission in Low BMI Chinese patients after bariatric surgery. *Obesity Surgery,31*(5), 2304-2304. doi:10.1007/s11695-020-05195-8

Koini, D. (2021, June 16). The vicious circle of obesity. Retrieved September 02, 2021, from https://functionalmedicalcorporation.uk/the-vicious-circle-of-obesity/

LeRoith, D., Biessels, G. J., Braithwaite, S. S., Casanueva, F. F., Draznin, B., Halter, J. B., . . . Sinclair, A. J. (2019). Treatment of diabetes in older adults: An endocrine society* clinical practice guideline. *The Journal of Clinical Endocrinology & Metabolism,104*(5), 1520-1574. doi:10.1210/jc.2019-00198

Mehrabian, F., Omidi, S., Mahdavi Roshan, M., &Mirzaee, M. (2018). Correlation between nutritional Behavior, obesity, and overweight in female elementary school students IN ANZALI [Abstract]. *Journal of Health,9*(3), 291-301. doi: 10.29252/j.health.9.3.291

MP, D., R, S., I, R., S, S., R, P., & V, B. (2018). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: A pooled analysis of 2416 population-based measurement studies in 128.9 million Children, adolescents and adults. *Yearbook of Paediatric Endocrinology*. doi:10.1530/ey.15.13.20

Organization., World Health WHO factsheet on obesity and overweight: World Health Organization fact sheet, 2020. (2021, April 12). Retrieved September 01, 2021, from https://www.who.int/news-room/facts-in-pictures/detail/6-facts-on-obesity

Rudrapal, M., Hussain, N., &Egbuna, C. (2021). Diabetes mellitus and it management

with plant-based therapy. *Dietary Phytochemicals,* 125-145. doi:10.1007/978-3-030-72999-8_7

Strongbeasts, L. (2019, December 01). "Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies". Retrieved September 01, 2021, from https://strongbeasts.wordpress.com/2019/12/01/obesity-the-real-causes/

Tester, J. M., Rosas, L. G., & Leung, C. W. (2020). Food insecurity and pediatric obesity: A double whammy in the era of covid-19. *Current Obesity Reports,9*(4), 442-450. doi:10.1007/s13679-020-00413-x

Wirth, J., Joshi, A. D., Song, M., Lee, D. H., Tabung, F. K., Fung, T. T., . . . Wu, K. (2020). A healthy lifestyle pattern and the risk of SYMPTOMATIC Gallstone DISEASE: Results from 2 prospective cohort studies. *The American Journal of Clinical Nutrition,112*(3), 586-594. doi:10.1093/ajcn/nqaa154

World Health Organization. (2016). *Obesity and overweight*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.