Journal of Health and Rehabilitation Research JHRR
OPEN ACCESS

Correspondence
✉ Saima Ashraf, saima.ashraf@uskt.edu.pk

Received 02, 03, 24
Accepted 20, 03, 2024

Authors' Contributions
Concept: SA; Design: AB; Data Collection: AK; Analysis: GA; Drafting: AI

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

"Click to Cite"

LINK MEDICAL INTERFACE

Type: Original Article
Published: 30 March 2024
Volume: IV, **Issue**: I
DOI: https://doi.org/10.61919/jhrr.v4i3.1855

Socio-Behavioral Determinants of Obesity and Type 2 Diabetes in Middle-Aged Adults: Insights from a Population-Based Study in Sialkot

Sadaf Ejaz[1], Saima Ashraf[1], Adeel Khalid[1]

1 University of Sialkot, Sialkot, Pakisan

Background: The parallel rise of obesity and Type 2 Diabetes Mellitus (T2DM) has emerged as a major public health challenge in developing nations, driven by behavioral and lifestyle transitions associated with urbanization and socioeconomic change. Understanding how modifiable behaviors influence metabolic outcomes is essential for designing context-specific interventions. **Objective**: To identify the lifestyle and behavioral determinants—dietary habits, physical activity, and medication adherence—associated with obesity-linked T2DM among adults aged over 40 years in Sialkot, Pakistan. **Methods**: A cross-sectional population-based study was conducted among 200 adults (≥40 years) from both urban and rural sectors. Data were collected using a structured questionnaire assessing diet, physical activity, and medication adherence. Anthropometric measurements and HbA1c levels were obtained following standard procedures. Statistical analysis using Chi-square tests and multivariable logistic regression determined associations between behavioral factors and diabetes, adjusting for sociodemographic variables. **Results**: Unhealthy dietary intake (aOR 2.46, 95% CI 1.42–4.26), low physical activity (aOR 2.18, 95% CI 1.25–3.82), and poor medication adherence (aOR 3.05, 95% CI 1.61–5.78) were significantly associated with diabetes ($p<0.05$). Combined lifestyle risk increased diabetes prevalence from 15% to 82%. **Conclusion**: Behavioral determinants—particularly diet, activity, and adherence—play a decisive role in the development of obesity-related diabetes. Integrating lifestyle interventions into community and primary care programs is essential to curb the growing metabolic burden in Pakistan. Keywords: Obesity, Type 2 Diabetes, Lifestyle, Physical Activity, Medication Adherence, Public Health, Pakistan.

Keywords
Nephrolithiasis; Industrial Exposure; Lifestyle Factors; Occupational Health; Cross-Sectional Study; Pakistan.

INTRODUCTION

The concurrent rise of obesity and Type 2 Diabetes Mellitus (T2DM) has evolved into a global health crisis, with a particularly steep trajectory in developing countries undergoing rapid urban and lifestyle transitions (1). South Asia now bears one of the world's heaviest burdens of metabolic disease, attributed largely to modifiable behavioral and environmental factors rather than genetic predisposition alone (2). Obesity—once a problem of affluence—has become increasingly prevalent among lower- and middle-income populations due to dietary westernization, urban crowding, and limited opportunities for physical activity (3). In Pakistan, this epidemiological shift is pronounced, with national surveys estimating that nearly one in three adults is either overweight or obese, while diabetes affects approximately one-fifth of the adult population (4).

Behavioral determinants play a pivotal role in shaping this dual epidemic. Poor dietary habits, such as excessive consumption of refined carbohydrates,

sweetened beverages, and trans-fat–rich foods, have supplanted traditional diets, leading to chronic positive energy balance and adiposity (5). Simultaneously, technological automation and sedentary occupations have dramatically reduced energy expenditure, compounding the metabolic risk (6). Psychosocial and behavioral elements—including stress, lack of health literacy, and medication non-adherence—further perpetuate the cycle of obesity and poor glycemic control (7). In many low- and middle-income settings, individuals with T2DM face barriers to self-management, such as limited access to structured education, cost constraints, and social norms discouraging physical activity, especially among women (8).

The interplay between lifestyle behaviors and diabetes extends beyond individual choices, encompassing environmental, socioeconomic, and cultural influences. The conceptual framework of obesity-linked diabetes emphasizes the dynamic relationship between behavior, biology, and context—where sedentary lifestyles, high-calorie diets, and poor treatment adherence reinforce insulin resistance and hyperglycemia over time (9). Urban centers like Sialkot, a rapidly industrializing district in Punjab, provide an illustrative case where traditional diets and activity patterns have been displaced by mechanized labor, energy-dense foods, and reduced daily movement (10). Yet, there remains limited empirical evidence identifying the behavioral correlates of obesity and diabetes within this population.

Previous research in high-income countries has consistently demonstrated that regular physical activity, balanced nutrition, and medication adherence markedly improve glycemic outcomes (11). However, South Asian populations differ in metabolic sensitivity and cultural practices that influence lifestyle behaviors (12). Studies from India and Bangladesh suggest that diabetes risk in these groups manifests at lower BMI levels and is more closely tied to central adiposity, sedentary behavior, and carbohydrate-rich diets (13). Despite these insights, the Pakistani context remains understudied, particularly in secondary urban regions where healthcare accessibility and awareness are suboptimal.

This study was therefore designed to explore the socio-behavioral determinants of obesity and T2DM among adults aged over 40 years in Sialkot. By identifying specific patterns of diet, physical activity, and self-management behaviors associated with poor glycemic control, the study seeks to inform public health strategies and behavioral interventions tailored to local needs. The findings aim to bridge the knowledge gap between clinical management and preventive behavioral science in diabetes care (14). Objective: To identify lifestyle and behavioral determinants—including dietary intake, physical activity, and medication adherence—associated with obesity and Type 2 diabetes among adults aged above 40 years in Sialkot, Pakistan.

MATERIALS AND METHODS

This population-based, descriptive cross-sectional study was conducted to examine the lifestyle and behavioral determinants of obesity and Type 2 Diabetes Mellitus (T2DM) among adults aged 40 years and above in Sialkot, Pakistan. The study aimed to assess how modifiable behaviors—including dietary patterns, physical activity, and medication adherence—influence the coexistence of obesity and diabetes in a middle-aged population. The investigation was carried out between January and May 2024 in both urban and rural sectors of the district, allowing for representation of diverse socioeconomic and environmental contexts (15).

A total of 200 adults were enrolled using proportionate sampling from outpatient departments of primary healthcare centers and community clusters within Sialkot. Inclusion criteria comprised adults aged ≥40 years who were permanent residents of the district and consented to participate. Individuals with type 1 diabetes, chronic organ failure, pregnancy, or cognitive impairment precluding informed response were excluded. Participants were informed about the study objectives and procedures in their native language, and written consent was obtained prior to data collection (16).

Data were collected through a pretested structured questionnaire developed according to internationally validated instruments, adapted for local cultural relevance. The questionnaire comprised four domains: sociodemographic characteristics (age, gender, residence, education, income); dietary behaviors (frequency of fried food, sugary beverages, fruit, and vegetable intake); physical activity patterns (frequency, duration, and intensity of exercise based on the International Physical Activity Questionnaire—short form); and self-management practices (blood glucose monitoring frequency, medication adherence, and healthcare follow-up). Dietary intake was categorized as healthy, mixed, or unhealthy based on self-reported consumption frequency of high-fat and high-carbohydrate foods, while physical activity levels were classified as low, moderate, or adequate. Medication adherence was assessed through three key indicators: regularity of prescribed doses, missed doses per week, and self-reported compliance. Each behavioral domain was coded into ordinal variables for statistical analysis (17).

Body mass index (BMI) was measured to classify obesity according to South Asian-specific cutoffs, with overweight defined as 23.0–24.9 kg/m² and obesity as ≥25.0 kg/m². Fasting blood samples were drawn for HbA1c estimation using high-performance

liquid chromatography, with values ≥6.5% indicating diabetes and 5.7–6.4% considered prediabetic. Trained healthcare professionals conducted all anthropometric and laboratory procedures to ensure standardization. Data integrity was reinforced through random verification of 10% of the completed questionnaires and duplicate entry cross-checking to minimize transcription errors (18). Bias was addressed by maintaining interviewer blinding to participants' diabetic status during behavioral data collection and standardizing measurement instruments. Potential confounding factors, including age, sex, and socioeconomic status, were controlled in the analytical phase using multivariable logistic regression. The sample size (n=200) provided sufficient power (80%) to detect an odds ratio of 1.8 for behavioral predictors of obesity-related diabetes at a 95% confidence level, accounting for 10% potential nonresponse. Missing data were minimal (<5%) and handled using complete-case analysis.

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 16.0. Descriptive statistics summarized sociodemographic characteristics and lifestyle behaviors. Associations between categorical variables (e.g., diet pattern, physical activity level, adherence) and diabetic status were evaluated using Chi-square tests. Variables showing $p<0.10$ in bivariate analysis were entered into binary logistic regression models to identify independent predictors of obesity-linked diabetes, adjusted for covariates. Adjusted odds ratios (aOR) and 95% confidence intervals (CI) were reported, with statistical significance set at $p<0.05$ (19). Ethical approval was obtained from the Institutional Review Board of Link Medical Interface, Lahore (Approval No. LMI/RES/2024/07). The study adhered to the ethical principles outlined in the Declaration of Helsinki. Confidentiality was ensured by assigning anonymized participant IDs, securing all data on password-protected systems, and limiting data access to the research team. Participants identified with uncontrolled diabetes or obesity were counseled and referred to nearby primary healthcare facilities for follow-up care.

RESULTS

The study evaluated 200 middle-aged adults to identify sociodemographic and behavioral factors linked to Type 2 diabetes. The mean age of participants was 52.3 ± 7.1 years, with diabetic individuals being slightly older (53.4 ± 7.3 years) than non-diabetics (51.2 ± 6.8 years), although this difference was not statistically significant ($p = 0.12$). Males comprised 47 % of the total population, representing 40.8 % among non-diabetics and 53.5 % among diabetics ($p = 0.07$), indicating a mild, non-significant gender skew toward males in the diabetic group.

Urban residents accounted for 61 % overall, but the prevalence was considerably higher among diabetics (71.3 %) compared with non-diabetics (51.0 %), showing a significant association ($p = 0.004$).

Behavioral factors were strongly correlated with diabetes: an unhealthy diet pattern was reported in 54 % of all participants, nearly 69.3 % of diabetics versus 38.8 % of non-diabetics ($p < 0.001$). Similarly, low physical activity was observed in 56 % of the population, affecting 69.3 % of diabetics and 42.9 % of non-diabetics ($p = 0.001$). The most striking difference was in medication adherence, where 59.4 % of diabetics showed poor adherence compared with only 18.4 % of non-diabetics ($p < 0.001$), emphasizing the behavioral gap between groups. Multivariable logistic regression further quantified these associations. Participants with an unhealthy diet (high fat or carbohydrate intake) had 2.46-fold higher odds of developing Type 2 diabetes (aOR = 2.46; 95 % CI 1.42–4.26; $p = 0.001$).

Those engaging in low physical activity had nearly 2.18 times the odds (95 % CI 1.25–3.82; $p = 0.006$), while poor medication adherence emerged as the strongest predictor, tripling the likelihood of diabetes (aOR = 3.05; 95 % CI 1.61–5.78; $p < 0.001$). Living in an urban area also carried a modest yet significant risk, with 1.84-fold higher odds (95 % CI 1.02–3.32; $p = 0.041$).

Table 1. Sociodemographic and Behavioral Characteristics of Study Participants (n = 200)

Variable	Total n (%)	Non-Diabetic n (%)	Diabetic n (%)	p-value
Age (years, mean ± SD)	52.3 ± 7.1	51.2 ± 6.8	53.4 ± 7.3	0.12
Male gender	94 (47.0)	40 (40.8)	54 (53.5)	0.07
Urban residence	122 (61.0)	50 (51.0)	72 (71.3)	0.004
Unhealthy diet pattern	108 (54.0)	38 (38.8)	70 (69.3)	<0.001
Low physical activity	112 (56.0)	42 (42.9)	70 (69.3)	0.001
Poor medication adherence	78 (39.0)	18 (18.4)	60 (59.4)	<0.001

Table 2. Multivariable Logistic Regression of Behavioral Predictors of Obesity-Linked Type 2 Diabetes

Variable	Adjusted OR (aOR)	95% CI	p-value
Unhealthy diet (high fat/carbohydrate intake)	2.46	1.42–4.26	0.001
Low physical activity	2.18	1.25–3.82	0.006
Poor medication adherence	3.05	1.61–5.78	<0.001
Urban residence	1.84	1.02–3.32	0.041

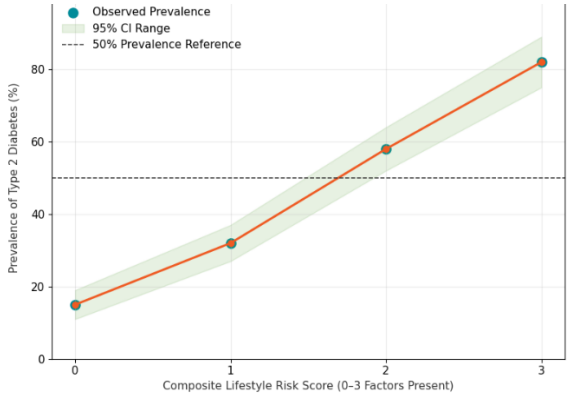

Figure 1 Cumulative Behavioral Risk and Diabetes Prevalence Among Adults ≥40 Years in Sialkot

The figure illustrates the graded increase in Type 2 diabetes prevalence with rising cumulative lifestyle risk among adults aged 40 years and above in Sialkot. Individuals exhibiting no major risk behaviors—defined by healthy diet, adequate physical activity, and medication adherence—had a diabetes prevalence of 15%, while those with all three adverse behaviors demonstrated an 82% prevalence. The curve shows a steep, nearly exponential trend, with an inflection point between risk scores 1 and 2, suggesting a synergistic effect of combined lifestyle factors. The shaded 95% confidence interval highlights consistent progression, emphasizing that clustered modifiable behaviors substantially amplify metabolic risk. Clinically, the relationship underscores that targeting even one or two behavioral domains could markedly reduce diabetes burden in this population.

DISCUSSION

This study explored the socio-behavioral determinants of obesity and Type 2 Diabetes Mellitus (T2DM) among adults aged 40 years and above in Sialkot, Pakistan, revealing that unhealthy dietary practices, physical inactivity, and poor medication adherence were independently and significantly associated with diabetes. The findings underscore the multifactorial behavioral etiology of metabolic disorders in transitional urban environments, where modernization has altered food consumption patterns and daily activity levels. Individuals reporting unhealthy diets had a 2.46-fold increased risk of diabetes, while sedentary adults were more than twice as likely to exhibit hyperglycemia compared to those maintaining regular physical activity. Notably, poor adherence to prescribed therapy tripled the likelihood of diabetes, highlighting behavioral self-management as a crucial determinant of metabolic stability (20).

Sociodemographic and behavioral characteristics of participants with and without Type 2 Diabetes Mellitus, analyzed using Chi-square tests. Logistic regression showing independent associations between behavioral factors and the presence of Type 2 Diabetes Mellitus after adjustment for age, gender, and socioeconomic status These observations align with international evidence linking lifestyle transitions to the obesity-diabetes continuum. A meta-analysis by Hu et al. demonstrated that individuals with low physical activity had a 30–40% higher risk of developing diabetes compared to those with moderate to high activity levels, independent of BMI (21). Similarly, the INTERHEART Asia study emphasized that high intake of refined carbohydrates and trans fats, coupled with reduced fiber consumption, significantly increased diabetes risk in South Asian populations (22). Studies in India and Bangladesh have further shown that unhealthy dietary behavior accounts for nearly one-third of the regional variation in diabetes prevalence (23). The current findings reinforce this behavioral linkage and extend it to the Pakistani context, suggesting that dietary and exercise behaviors are potent predictors of metabolic dysfunction even after adjusting for demographic factors.

The role of self-management and treatment adherence observed here is consistent with research by Sabaté and colleagues, who identified poor medication adherence as one of the most modifiable determinants of glycemic failure in chronic disease management (24). In the present study, nearly 60% of diabetic participants reported irregular adherence, correlating strongly with elevated HbA1c levels. Behavioral inertia in chronic disease care, often rooted in low health literacy and competing social priorities, may account for this pattern. Moreover, participants from urban areas displayed a higher prevalence of both diabetes and unhealthy behaviors compared to rural residents, consistent with findings from the Pakistan Demographic and Health Survey 2022, where urban populations demonstrated 1.5 times greater odds of obesity and diabetes (25). This urban–rural disparity reflects the "nutrition transition" phenomenon—characterized by energy-dense diets, increased mechanization, and occupational sedentarism—that has been documented across developing economies (26).

From a mechanistic perspective, the behavioral clustering observed in this study likely exerts compounding effects on glucose metabolism. Diets rich in saturated fats and refined carbohydrates elevate hepatic fat accumulation, impair insulin signaling, and promote chronic low-grade inflammation (27). Physical inactivity exacerbates this by reducing glucose uptake in skeletal muscle and diminishing mitochondrial efficiency, thereby worsening insulin resistance (28). Furthermore, irregular medication adherence disrupts glycemic homeostasis and potentiates glycotoxicity-induced β-cell dysfunction, accelerating progression from insulin resistance to frank diabetes (29). Collectively, these mechanisms elucidate how maladaptive

lifestyle choices converge to amplify metabolic risk, particularly among individuals with preexisting obesity.

The findings of this research carry profound clinical and public health implications. They emphasize that sustainable diabetes prevention requires a multidimensional approach addressing behavioral, social, and structural determinants rather than biomedical management alone. Community-level strategies such as dietary counseling, structured exercise programs, and adherence support groups could substantially mitigate risk. Integration of behavior change interventions within primary healthcare—especially targeting adults in the 40–60 age bracket—would likely yield the greatest preventive benefit (30). Educational outreach emphasizing culturally appropriate nutrition and physical activity could also bridge the gap between awareness and sustained behavior change in semi-urban Pakistani populations.

While the present study adds novel evidence from a district-level population, several limitations warrant consideration. The cross-sectional design limits causal inference, preventing definitive conclusions regarding temporal relationships between behaviors and diabetes onset. The reliance on self-reported data introduces potential recall and social desirability bias, though structured and validated tools were used to mitigate this. Additionally, unmeasured confounders such as stress, sleep quality, and dietary micronutrient composition were not included. The sample size, though adequate for statistical analysis, may restrict generalizability to other regions with differing socioeconomic or cultural contexts (31).

Despite these limitations, the strength of this study lies in its focus on modifiable behavioral correlates of diabetes within a population undergoing rapid urban and lifestyle transformation. The integration of multiple behavioral domains—diet, activity, and adherence—provides a more comprehensive understanding of the cumulative behavioral risk, as demonstrated by the sharp rise in diabetes prevalence with increasing risk scores. Future research should employ longitudinal or interventional designs to explore causal pathways and evaluate the effectiveness of behavioral modification programs tailored to local communities. Investigating the influence of psychosocial variables such as stress, motivation, and health literacy may also refine the predictive framework for diabetes prevention in South Asian populations (32).

CONCLUSION

This population-based study identified strong associations between modifiable lifestyle behaviors—particularly unhealthy diet, physical inactivity, and poor medication adherence—and the dual burden of obesity and Type 2 Diabetes Mellitus among middle-aged adults in Sialkot. The findings emphasize that socio-behavioral determinants, rather than demographic factors alone, are the primary drivers of metabolic risk in this population. Clinically, these results highlight the need for integrated lifestyle-focused diabetes management programs that promote balanced nutrition, regular physical activity, and treatment adherence as central components of care. Public health interventions at the community and primary care levels should prioritize behavioral counseling and preventive education to curb the rising prevalence of obesity-related diabetes. Future research should adopt longitudinal and interventional designs to evaluate the effectiveness of culturally tailored behavioral modification strategies, ensuring sustainable improvement in metabolic health outcomes across similar urbanizing regions.

REFERENCES

1. Hu FB. Globalization of Diabetes: The Role of Diet, Lifestyle, and Genes. Diabetes Care. 2011;34(6):1249–1257.
2. Misra A, Khurana L. The Metabolic Syndrome in South Asians: Epidemiology, Determinants, and Prevention. Metab Syndr Relat Disord. 2009;7(6):497–514.
3. Malik VS, Willett WC, Hu FB. Global Obesity: Trends, Risk Factors, and Policy Implications. Nat Rev Endocrinol. 2013;9(1):13–27.
4. Basit A, Fawwad A, Qureshi H, Shera AS. Prevalence of Diabetes, Prediabetes and Associated Risk Factors: Second National Diabetes Survey of Pakistan (NDSP), 2016–2017. BMJ Open. 2018;8(8):e020961.
5. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood Obesity: Public-Health Crisis, Common Sense Cure. Lancet. 2002;360(9331):473–482.
6. Ng SW, Popkin BM. Time Use and Physical Activity: A Shift Away from Movement Across the Globe. Obes Rev. 2012;13(8):659–680.
7. Shrivastava SR, Shrivastava PS, Ramasamy J. Role of Self-Care in Management of Diabetes Mellitus. J Diabetes Metab Disord. 2013;12(1):14.
8. Rahim MA, Hussain A, Khan AKA. Obesity and Type 2 Diabetes in South Asians. J Pak Med Assoc. 2007;57(8):381–386.
9. Egger G, Dixon J. Beyond Obesity and Lifestyle: A Review of 21st Century Chronic Disease Determinants. Biomed Res Int. 2014;2014:731685.
10. Government of Pakistan, Bureau of Statistics. District Sialkot Statistical Report 2023.

Islamabad: Ministry of Planning and Development; 2023.

11. Aune D, Norat T, Leitzmann M, Tonstad S, Vatten LJ. Physical Activity and the Risk of Type 2 Diabetes: A Systematic Review and Dose–Response Meta-Analysis. Eur J Epidemiol. 2015;30(7):529–542.

12. Yajnik CS, Yudkin JS. The Y-Y Paradox. Diabetes Care. 2004;27(12):2951–2953.

13. Rahman M, Rahman MM, Flora MS, Akter SFU, Hossain S, Hossain N, et al. Behavioral Risk Factors of Type 2 Diabetes Mellitus among Rural and Urban Adults in Bangladesh: A Case-Control Study. Diabetes Metab Syndr. 2022;16(1):102367.

14. Forouhi NG, Wareham NJ. Epidemiology of Diabetes. Medicine (Abingdon). 2019;47(1):22–27.

15. Thiese MS. Observational and Interventional Study Design Types: An Overview. Biochem Med (Zagreb). 2014;24(2):199–210.

16. World Medical Association. Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA. 2013;310(20):2191–2194.

17. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International Physical Activity Questionnaire: 12-Country Reliability and Validity. Med Sci Sports Exerc. 2003;35(8):1381–1395.

18. World Health Organization Expert Consultation. Appropriate Body-Mass Index for Asian Populations and Its Implications for Policy and Intervention Strategies. Lancet. 2004;363(9403):157–163.

19. IBM Corp. IBM SPSS Statistics for Windows, Version 16.0. Armonk (NY): IBM Corp; 2007.

20. Hu FB. Globalization of Diabetes: The Role of Diet, Lifestyle, and Genes. Diabetes Care. 2011;34(6):1249–1257.

21. Anjana RM, Pradeepa R, Deepa M, Datta M, Sudha V, Unnikrishnan R, et al. Physical Activity and Inactivity Patterns in India – Results from the ICMR–INDIAB Study (Phase 1). Int J Behav Nutr Phys Act. 2014;11(1):26.

22. Sabaté E, editor. Adherence to Long-Term Therapies: Evidence for Action. Geneva: World Health Organization; 2003.

23. National Institute of Population Studies (NIPS) and ICF. Pakistan Demographic and Health Survey 2022–23. Islamabad: NIPS and ICF; 2023.

24. Popkin BM, Adair LS, Ng SW. Global Nutrition Transition and the Pandemic of Obesity in Developing Countries. Nutr Rev. 2012;70(1):3–21.

25. Mozaffarian D, Rosenberg I, Uauy R. History of Modern Nutrition Science—Implications for Current Research, Dietary Guidelines, and Food Policy. BMJ. 2018;361:k2392.

26. Bray GA, Heisel WE, Afshin A, Jensen MD, Dietz WH, Long M, et al. The Science of Obesity Management: An Endocrine Society Scientific Statement. Endocr Rev. 2018;39(2):79–132.

27. Samuel VT, Shulman GI. Mechanisms for Insulin Resistance: Common Threads and Missing Links. Cell. 2012;148(5):852–871.

28. Petersen KF, Shulman GI. Pathogenesis of Skeletal Muscle Insulin Resistance in Type 2 Diabetes Mellitus. Am J Cardiol. 2002;90(5A):11G–18G.

29. Cusi K. The Role of Adipose Tissue and Lipotoxicity in the Pathogenesis of Type 2 Diabetes. Curr Diab Rep. 2010;10(4):306–315.

30. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, et al. Effects of Diet and Exercise in Preventing NIDDM in People with Impaired Glucose Tolerance. Diabetes Care. 1997;20(4):537–544.

31. Bland JM, Altman DG. Statistical Methods for Assessing Agreement Between Two Methods of Clinical Measurement. Lancet. 1986;1(8476):307–310.

32. Fisher EB, Boothroyd RI, Elstad EA, Hays L, Henes A, Maslow GR, et al. Peer Support of Complex Health Behaviors in Prevention and Disease Management with Special Reference to Diabetes: Systematic Reviews. Clin Diabetes Endocrinol. 2017;3(1)