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ORIGINAL ARTICLE

The Interrelationship between Type 2 Diabetes Mellitus, Functional Gastrointestinal Disorders, and Polycystic Ovary Syndrome in Reproductive Age Women

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ABSTRACT

Background: Type 2 diabetes mellitus, polycystic ovary syndrome and functional gastrointestinal disorders are highly prevalent in reproductive-age women and share overlapping risk factors such as insulin resistance, obesity, and hormonal dysregulation.

Objectives: To evaluate the prevalence and associations of polycystic ovary syndromes and functional gastrointestinal disorders in reproductive-age women with Type 2 diabetes mellitus, and to identify independent predictors of functional gastrointestinal disorders in this population.

Methodology: This cross-sectional analytical study was conducted at Department of Diabetes & Endocrinology and Obstetrics & Gynaecology, Shaheed Mohtarma Benazir Bhutto Medical University Larkana from 1st April 2023 to 30th September 2023. Two hundred and twenty reproductive-age women with type 2 diabetes mellitus were included in the study. Polycystic ovary syndrome was diagnosed using the Rotterdam criteria, and functional gastrointestinal disorders were identified according to Rome IV guidelines. Clinical, demographic, and metabolic parameters were recorded.

Results: The mean age of participants was 31.8±6.4 years, mean body mass index was 28.3±4.7 kg/m², and mean duration of diabetes was 5.2±3.1 years. Polycystic ovary syndrome was diagnosed in 82 women (37.3%), and functional gastrointestinal disorders were present in 94 women (42.7%), with irritable bowel syndrome being the most common subtype (20.9%). Women with functional gastrointestinal disorders had higher body mass index (29.5±4.9 vs. 27.4±4.3, p=0.003), longer duration of diabetes (6.1±3.4 vs. 4.6±2.9 years, p=0.001), and higher HbA1c levels (8.1±1.4 vs. 7.6±1.2, p=0.01). Logistic regression identified polycystic ovary syndrome (OR 2.15, 95% CI: 1.28–3.64, p=0.004), body mass index ≥28 kg/m² (OR 1.87, 95% CI: 1.12–3.12, p=0.016), and diabetes duration ≥5 years (OR 2.03, 95% CI: 1.21–3.41, p=0.007) as independent predictors of functional gastrointestinal disorders.

Conclusion: Functional gastrointestinal disorders are highly prevalent in reproductive-age women with type 2 diabetes mellitus and are strongly associated with polycystic ovary syndrome, obesity, and longer diabetes duration. The coexistence of type 2 diabetes mellitus, polycystic ovary syndrome, and functional gastrointestinal disorders represents a compounded health burden, underscoring the need for integrated multidisciplinary management strategies to improve reproductive, metabolic, and gastrointestinal outcomes.

Keywords: Type 2 diabetes mellitus, Polycystic ovary syndrome, Functional gastrointestinal disorders, Irritable bowel syndrome

INTRODUCTION

Type 2 diabetes mellitus (T2DM), functional gastrointestinal disorders (FGIDs), and polycystic ovary syndrome (PCOS) represent a triad of conditions that are increasingly recognized as interrelated, especially among women of reproductive age.[1] All of these conditions, individually, have a high morbidity level as well as a negative impact on the quality of life and long-term health outcomes. Nevertheless, in combination, they make up a complex clinical image, complicating accurate diagnosis and choice of treatment.[2] Knowledge of their interrelationship is imperative in enhancing the health outcomes of women, especially where metabolic and endocrine disorders are becoming common. The major characteristic of T2DM is the condition of insulin resistance and relative 6-cell dysfunction that causes a person to develop chronic hyperglycemia.[3]

Although historically thought of as a disorder that only affected middle-aged and older adults, recently disturbing trends have reflected the involvement of younger people, even females who are of childbearing age. In large part, the trend is facilitated by the presence of obesity and a sedentary lifestyle as well as dietary changes.[4] The burden of T2DM in reproductive-age women is not only metabolic but reproductive, because it predisposes women to infertility and pregnancy and adverse neonatal outcomes. In addition, its metabolic effects are largely similar to those of PCOS, indicating a communized pathophysiological framework.[5] PCOS is one of the most prevalent causes of anovulatory infertility, and roughly 6-15 percent of women of reproductive age.[6] The syndrome varies widely, but is typically distinguished by hyperandrogenism, menstrual disorders, and polycystic ovary morphology. At its center stands insulin resistance that is reported to affect up to 70 percent of the affected women, regardless of body mass index.[7]

By advancing androgen production in the ovaries, hyperinsulinemia has complemented the characteristics ventilated, providing in like manner improving the fragility of poor glucose tolerance and explicit type 2 diabetes.[8] The interrelationship is two-way, which is why female T2DM risk among women with PCOS is doubled and even quadrupled in comparison to that risk among women without PCOS. The highlighting commonality of dysregulated metabolic flooring promotes the need to investigate PCOS and T2DM not as distinct but interconnected disorders as a part of a larger reproductive-metabolic continuum.[9] Meanwhile irritable bowel syndrome (IBS), functional dyspepsia, and chronic constipation are also common FGIDs among women with T2DM or PCOS. Autonomic neuropathy, delayed gastric emptying, and the inability of the enteric nervous system to regulate gastrointestinal disturbances are the suspected causes of gastrointestinal manifestations in T2DM. Nevertheless, regardless of the lack of higher complications, functional symptoms, represented by the patient's complaints of bloating, abdominal pain, and disrupted bowel habits, are common in many patients.[10]

Gastrointestinal symptoms, including gastrointestinal distress, have become frequently reported in women with PCOS,

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and evidence is emerging to indicate the involvement of low-grade inflammation, gut microbiome, and hormonal changes in the production of symptoms. Moreover, psychosocial conditions like anxiety and depression that can take place in both T2DM and PCOS can contribute to the intensification of the perception and severity of the FGID symptoms.[11]

The role of the gut-metabolic axis is one of the most interesting points that connect the three conditions. Insulin resistance, systemic inflammation, and reproductive hormonal imbalances have been related to dysbiosis, high intestinal permeability, and microbial metabolite dysregulation. It has also been suggested that the gut microbiota affects ovarian function through the modulation of sex hormone metabolism, whilst also acting on gastrointestinal motor and sensory function.[12] Therefore, FGIDs do not necessarily co-exist with T2DM and PCOS but are a potential intermediate reflection of the acutely disturbed gut-endocrine-metabolic system. That shows the significance of paying attention to the gastrointestinal health in the cogent treatment of women with metabolic and reproductive disorders. This intersection of conditions has momentous implications.[13]

The occurrence of T2DM, PCOS, and FGIDs in women has the potential to be compounded in terms of health risks, such as subfertility, gestational complications, augmented cardiovascular risk, and lower psychosocial well-being. Notably, the same lifestyle risk factors, which can be modified by changing lifestyle choices, such as diet, obesity, and physical inactivity, apply to these conditions, which is an indicator that holistically involving them in interventions and early treatment may therefore be highly beneficial.[14] Notwithstanding this, the majority of clinical research has tended to treat these disorders in isolation, creating a lack of insight into the cumulative effects of these disorders.[15]

PATIENTS AND METHODS

This was a cross-sectional analytical study conducted at the Department of Diabetes & Endocrinology and Obstetrics & Gynaecology, Shaheed Mohtarma Benazir Bhutto Medical University Larkana from 1st April 2023 to 30th September 2023. A total of 220 women of reproductive age were included in the study. Non-probability consecutive sampling was employed to recruit participants meeting the inclusion criteria. Sample size was calculated using WHO calculator. Written informed consent was taken from all participants, ensuring confidentiality and voluntary participation. All women aged 18–45 years with a confirmed diagnosis of type 2 diabetes mellitus were included, eligible regardless of duration of diabetes, but were required to have stable glycemic control for at least three months before enrollment were included. Those women with type 1 diabetes mellitus, gestational diabetes, known chronic liver disease, chronic kidney disease, thyroid disorders, or a history of major gastrointestinal surgery were excluded. Those currently on medications known to affect gastrointestinal motility (e.g., prokinetics, opioids) were also excluded to avoid confounding were excluded. After obtaining informed consent, participants were assessed through a structured questionnaire and clinical evaluation. Diagnosis of functional gastrointestinal disorders (FGIDs) was established based on the Rome IV criteria, with subtypes including irritable bowel syndrome, functional dyspepsia, and chronic constipation recorded. The presence of polycystic ovary syndrome (PCOS) was confirmed using the Rotterdam criteria (requiring two of three: oligo/anovulation, clinical/biochemical hyperandrogenism, and polycystic ovarian morphology on ultrasound). Relevant demographic data (age, BMI, duration of diabetes, and menstrual history), metabolic parameters (fasting glucose, HbA1c, lipid profile), and reproductive variables were documented. Data were entered and analyzed using SPSS-26.0. The prevalence of FGIDs and PCOS among diabetic women was determined. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of participants was 31.8±6.4 years, with an average BMI of 28.3±4.7 kg/m² and mean diabetes duration of 5.2±3.1 years. Most women were married (76.4%), and nearly two-thirds (64.5%) reported a family history of diabetes. Hypertension and dyslipidemia were also common, observed in 41.4% and 30.9% of participants, respectively. The prevalence of polycystic ovary syndrome (PCOS) was 37.3%, while functional gastrointestinal disorders (FGIDs) were present in 42.7%. Among FGIDs, irritable bowel syndrome (20.9%) was the most frequent, followed by functional dyspepsia (14.5%) and chronic constipation (7.3%) [Table 1].

Functional gastrointestinal disorders were significantly more common in the PCOS group (56.1% vs. 34.7%, p=0.002). In particular, irritable bowel syndrome was notably higher among women with PCOS (31.7% vs. 14.5%, p = 0.004), whereas functional dyspepsia (17.0% vs. 13.0%, p=0.48) and chronic constipation (7.3% vs. 7.2%, p=0.97) showed no significant differences (Table 2).

Further comparison between FGID and non-FGID groups revealed important metabolic differences. Women with FGIDs had a significantly higher BMI (29.5±4.9 vs. 27.4±4.3, p=0.003), longer duration of diabetes (6.1±3.4 vs. 4.6±2.9 years, p=0.001), and higher HbA1c levels (8.1±1.4 vs. 7.6±1.2, p=0.01). Age was similar between the two groups (32.2±6.1 vs. 31.5±6.7 years, p=0.41) [Table 3].

Analysis of overlapping conditions demonstrated that 40.9% of participants had T2DM without PCOS or FGIDs, whereas 16.4% had T2DM with PCOS only, 21.8% had T2DM with FGIDs only, and 20.9% were affected by all three conditions simultaneously (Table 4).

Table 1: Baseline demographic, clinical characteristics, and prevalence of PCOS and FGIDs (n = 220)

Variable	Value
Age (years)	31.8 ± 6.4
BMI (kg/m²)	28.3 ± 4.7
Duration of T2DM (years)	5.2 ± 3.1
Marital status – Married	168 (76.4%)
Marital status – Unmarried	52 (23.6%)
Family history of T2DM	142 (64.5%)
Hypertension	91 (41.4%)
Dyslipidemia	68 (30.9%)
PCOS & FGIDs	
PCOS	82 (37.3%)
Any FGID	94 (42.7%)
Irritable bowel syndrome	46 (20.9%)
Functional dyspepsia	32 (14.5%)
Chronic constipation	16 (7.3%)

Table 2: Comparison of functional gastrointestinal disorders in women with and Without polycystic ovary syndrome

Variable	PCOS Present (n=82)	PCOS Absent (n=138)	p-value
Any FGID	46 (56.1%)	48 (34.7%)	0.002*
IBS	26 (31.7%)	20 (14.5%)	0.004*
Functional dyspepsia	14 (17.0%)	18 (13.0%)	0.48
Chronic constipation	6 (7.3%)	10 (7.2%)	0.97**

*Statistically significant at p<0.05
** Non-Significant

Table 3: Comparison of clinical and metabolic parameters between functional gastrointestinal disorders (IFGIDs) and non-functional gastrointestinal disorders groups

Variable	FGIDs Present (n=94)	FGIDs Absent (n=126)	p-value
Age (years)	32.2±6.1	31.5±6.7	0.41
Body mass index (kg/m²)	29.5±4.9	27.4±4.3	0.003*
Duration of T2DM (years)	6.1±3.4	4.6±2.9	0.001*
HbA1c (%)	8.1±1.4	7.6±1.2	0.01*

*Statistically significant at p<0.05

Multivariate logistic regression identified PCOS as a significant independent predictor of FGIDs (OR 2.15, 95% CI: 1.28–3.64, p=0.004). Higher BMI (≥28 kg/m²) also increased FGID risk (OR 1.87, 95% CI: 1.12–3.12, p=0.016), as did longer diabetes duration (≥5 years) (OR 2.03, 95% CI: 1.21–3.41, p=0.007). Although HbA1c ≥8% showed a trend toward increased FGIDs (OR 1.56, 95% CI: 0.92–2.64), this was not statistically significant (p = 0.09) [Table 5].

Table 4: Overlap between type 2 diabetes mellitus (T2DM), polycystic ovary syndrome (PCOS) and functional gastrointestinal disorders (FGIDs)

Group	Frequency	Percentage
T2DM + PCOS only	36	16.4
T2DM + FGIDs only	48	21.8
T2DM + PCOS + FGIDs (all three)	46	20.9
T2DM without PCOS or FGIDs	90	40.9

Table 5: Multivariate logistic regression predictors of functional gastrointestinal disorders in women with type 2 diabetes mellitus

Predictor	Adjusted OR	95% CI	p-value
PCOS (present vs absent)	2.15	1.28 – 3.64	0.004*
BMI ≥ 28 kg/m²	1.87	1.12 – 3.12	0.016*
Duration of T2DM ≥ 5 years	2.03	1.21 – 3.41	0.007*
HbA1c ≥ 8%	1.56	0.92 – 2.64	0.09

*Statistically significant at p<0.05

DISCUSSION

This study investigated the interrelationship between type 2 diabetes mellitus (T2DM), functional gastrointestinal disorders (FGIDs), and polycystic ovary syndrome (PCOS) in reproductive-age women. In 220 participants, PCOS was detected in 37.3%, and FGIDs in 42.7%, the irritable bowel syndrome (IBS) was the dominant type. Noteworthy, FGIDs were substantially more prevalent in the PCOS than in the non-PCOS group of women, and the sole predictors that were independent of each other were the occurrence of PCOS, a greater BMI, and a longer duration of diabetes. The combination of the impacts of metabolic, reproductive, and gastrointestinal dysfunction in this population is also vindicated in these results. The rates of PCOS in our diabetic cohort are within those of past studies which consistently find elevated rates of PCOS in insulin-resistant women.[16] A common pathophysiologic feature of T2DM and PCOS is insulin resistance, and a hyperinsulinemic environment further exacerbates ovarian androgen synthesis and thus contributes to their reproductive metabolic abnormalities. Finding FGIDs and IBS more, was found to be more burdensome in women than in those PCOS, which means that the effects of hormonal imbalance and metabolic chaos may carry on to the intestines. This is indirect confirmation of the emerging concept of a gut+endocrine+metabolic axis that may underlie overlapping symptomatology.[17]

The correlation of FGIDs and metabolic factors, which is present in this study, corroborates the literature as well. Increased BMI, prolonged diabetes and worse glycemic control had significant associations with FGID prevalence. Such factors have been recognized to compromise normal stomach motility and visceral sensitivity and cause low-grade systemic inflammation which could be the explanation behind these associations. The increased glycemic control captured by elevated HbA1c in the FGID-positive individuals implies that ineffective glycemic regulation could be an additional factor that can adversely affect the gastrointestinal dysfunction, establishing the vicious cycle of metabolic and gastrointestinal disorders.[18] The relation of T2DM with PCOS and that of T2DM with FGIDs are also notable in our findings. The correlation of the three conditions was clinically relevant because about one in every five women in the sample experienced the combination of all three conditions. The significance of such clustering is that women facing this triad are at risk of having increased risks due to interdependence (such as risk of infertility, developing gestational and psychological complications, and increased morbidity of cardiovascular disease). The finding supports the fact that in clinical practice, there is an increased requirement of an integrated screening practice that does not address the conditions in a piecemeal manner.[19]

The multivariable analysis established the fact that PCOS is an independent predictor of FGIDs, and women with PCOS demonstrated an increased likelihood of developing gastrointestinal symptoms more than twice as high. It is in line with earlier studies that hyperandrogenism and changing hormones are associated with changing gut motility and microbiome.[20] In a similar strain, obesity and long diabetes duration were strong predictors, indicating the cumulative effect of metabolic stress on gastrointestinal health. Interestingly, elevated HbA1c was associated in a trend to higher FGID prevalence but was not statistically significant in regression analysis, indicating that perhaps greater importance is played by chronic insulin resistance/obesity than recent glycemic status.[21] Clinically these findings indicate that holistic management is significant in women with T2DM and PCOS. The evaluation of reproductive and metabolic health should include the routine use of gastrointestinal symptom screening. Additionally, lifestyle modification, weight loss, and glycemic control-focused interventions may be beneficial with a two-fold effect of alleviating metabolic and gastrointestinal upset. Investigations should consider further how the situation may be modulated by gut microbiota, dietary modulation, and hormonal interventions in the future as a means of reducing the compound burden of these conditions. Limitations of this study include its cross-sectional design, which prevents causal inference. The reliance on questionnaire-based FGID diagnosis may also be subject to recall bias. Furthermore, as the study was conducted in a single center, the findings may not be generalizable to broader populations. Despite these limitations, the relatively large sample size and systematic evaluation of PCOS, FGIDs, and metabolic parameters strengthen the reliability of the results

CONCLUSION

Functional gastrointestinal disorders are highly prevalent in reproductive-age women with type 2 diabetes mellitus and show a strong association with polycystic ovary syndrome. The coexistence of these conditions is driven by common pathophysiological mechanisms including insulin resistance, obesity, and prolonged disease duration. Women with PCOS were found to have significantly higher odds of developing FGIDs, particularly irritable bowel syndrome, highlighting the role of hormonal and metabolic dysregulation in gastrointestinal dysfunction. The overlap of T2DM, PCOS, and FGIDs represents a compounded health burden, predisposing women to infertility, adverse pregnancy outcomes, cardiovascular risks, and psychological distress.

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