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The Relationship Between Age at Diabetes Onset and Clinical Outcomes in Newly Diagnosed Type 2 Diabetes: A Real-World Two-Center Study

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Purpose: This study was developed with the goal of clarifying whether there is any relationship between type 2 diabetes mellitus (T2DM) age of onset and clinical outcomes for patients in National Metabolic Management Centers (MMC).

Patients and Methods: From September 2017 - June 2022, 864 total T2DM patients were recruited in MMC and assigned to those with early-onset and late-onset diabetes (EOD and LOD) based on whether their age at disease onset was ≤ 40 or > 40 years. All patients received standardized management. Baseline and 1-year follow-up data from these two groups of patients were assessed. Associations between onset age and other factors were evaluated with a multivariate linear regression approach, adjusting for appropriate covariates. Outcomes in particular subgroups were also assessed in stratified analyses.

Results: Markers of dysregulated glucose metabolism and BMI values were significantly higher among EOD patients as compared to LOD patients. Subjects in both groups exhibited significant improvements in several disease-related parameters on 1-year follow-up after undergoing metabolic management. EOD patients exhibited significantly greater percentage reductions in HbA1c levels (−28.49 (−44.26, −6.45)% vs −13.70 (−30.15,-1.60)%, P =0.017) relative to LOD patients following adjustment for confounders. Significant differences were also detected between these groups when focused on subgroups of patients who were male, exhibited a BMI ≥ 25, an HbA1c ≥ 9, or had a follow-up frequency < 2.

Conclusion: Data from a 1-year follow-up time point suggest that a standardized metabolic disease management model can promote effective metabolic control in newly diagnosed T2DM patients, particularly among individuals with EOD.

Keywords: age of onset, disease management, type 2 diabetes

Introduction

Diabetes is among the most common global forms of chronic disease, and is forecast to affect approximately 700 million people as of 2045.[1] Type 2 diabetes mellitus (T2DM) affects 11.2% of individuals in China over the age of 18,[2] resulting in massive economic costs for the Chinese healthcare system.[3] Persistent hyperglycemia can result in extensive damage the the vasculature, kidneys, nerves, kidneys, and cardiovascular system, leading to multi-systemic adverse complications.[4] Effective long-term glycemic control is necessary to prevent the onset of macrovascular and microvascular complications in individuals with diabetes, leading to the consumption of substantial medical resources in order to provide patients with appropriate care.[5,6]

The age at diabetes onset is becoming progressively younger at the global level, with a steady increase in the proportion of diabetic patients who are young or middle-aged.[7,8] Roughly 18% of Asian adults with T2DM have early-onset disease according to the Joint Asia Diabetes Evaluation (JADE) program,[9] and the respective prevalence rates of T2DM among individuals in China who are 18–29 and 30–39 years of age are 4.5% and 6.6%, while the rates of

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prediabetes among individuals under 40 years of age can reach 40–50%.[10] Early-onset diabetes (EOD) is defined by an early age of diagnosis, although different studies use age thresholds anywhere from 30–45 years,[11] with 40 years of age being the most common cut-off[12] Emerging data suggest that EOD may be more aggressive than late-onset diabetes (LOD), resulting in characteristically more rapid β-cell functional deterioration, the need for insulin treatment with greater frequency, and the potential for more common microvascular and macrovascular complications.[13] Indeed, EOD patients exhibit metabolic disorders and diabetic complications more severe than those of LOD patients.[14] Early-onset T2DM has also been linked to greater cardiovascular disease risk, morbidity, and mortality relative to T1DM.[15] In a cross-sectional analysis conducted based upon data derived from the China National HbA1c Surveillance System, those patients in China with early-onset T2DM were confirmed to present with greater nonfatal cardiovascular disease risk.[16]

Given the increasingly early-stage diagnosis of T2DM, there is an opportunity to implement standardized management practices more rapidly in an effort to reduce the risk of disease-related complications.[17] The National Metabolic Management Center (MMC) is an innovative effort that has been established as an approach to combatting metabolic disease and complications thereof in China.[18] The large MMC database has enabled a host of real-world studies designed to better clarify how current practices impact the disease course and clinical outcomes in diabetes patient populations, allowing for more effective screening for diabetic retinopathy[19] and the incidence of arterial stiffness.[20] The MMC model of metabolic disease management seeks to achieve greater treatment adherence and efficacy.[18]

While some studies have evaluated the benefits of standardized metabolic management using MMC patient data,[21,22] no studies to date have explored the link between age at diabetes onset and clinical outcomes. For a variety of reasons, patients with different onset ages are likely to exhibit a range of clinically relevant differences following standardized management, including islet function indices and changes in blood glucose levels. Accordingly, the present study was conducted with the goal of exploring how standardized management practices impact levels of blood glucose, islet function, and other metabolic indices in T2DM patients with different onset ages.

Materials and Methods

Study Subjects

This study was based on a database comprised of 8322 adults with T2DM who were recruited to the MMC of The Second People's Hospital of Yuhuan and Taizhou Central Hospital (Taizhou University Hospital) from September 2017 - June 2022. T2DM who were diagnosed in accordance with WHO criteria.[23] Only patients who were 18+ years old, non-pregnant, and diagnosed within the last year were eligible for this study. Those patients with a >12-month disease duration (n=6,043) or a follow-up duration < 12 months (n = 1,415) were omitted from these analyses, with 864 patients ultimately being enrolled in the final analyses (Figure 1). These patients were separated into EOD (n = 219) and LOD (n = 645) groups based on whether their age at disease onset was ≤ 40 or > 40 years, respectively. The local ethics committees provided ethical approval for this study, which was conducted as per the Declaration of Helsinki.

Data Collection and Study Variables

Data for MMC patients were collected including sociodemographic characteristics, laboratory results, medical treatments, and comorbid diseases based on available medical information. Based on the idea of "One Center, One Step, and One Standard Model", MMC is a national project to manage patients with metabolic conditions. For details regarding the MMC program, see prior studies.[21,22,24] On recruitment, all patient data were collected using a standardized protocol by trained staff members of local MMC. Following the completion of baseline evaluations, patients were advised to undergo routine MMC follow-up evaluations. On enrollment in the MMC program, individualized treatment goals were established for all patients based upon their characteristics in each MMC. Guidelines for treating T2DM in China were strictly implemented to ensure the comprehensive and standardized management of this metabolic disease. The current standard recommended follow-up frequency for MMC is 2–4 visits each year, but actual follow-up frequencies can be modulated by physicians based on a range of factors including the metabolic status of each patient. MMCs offer patients internet-based self-management support (apps, social software platforms, etc)., which includes online lectures, Q&A sessions with MMC doctors, blood glucose monitoring and reporting, and health education material and courses.

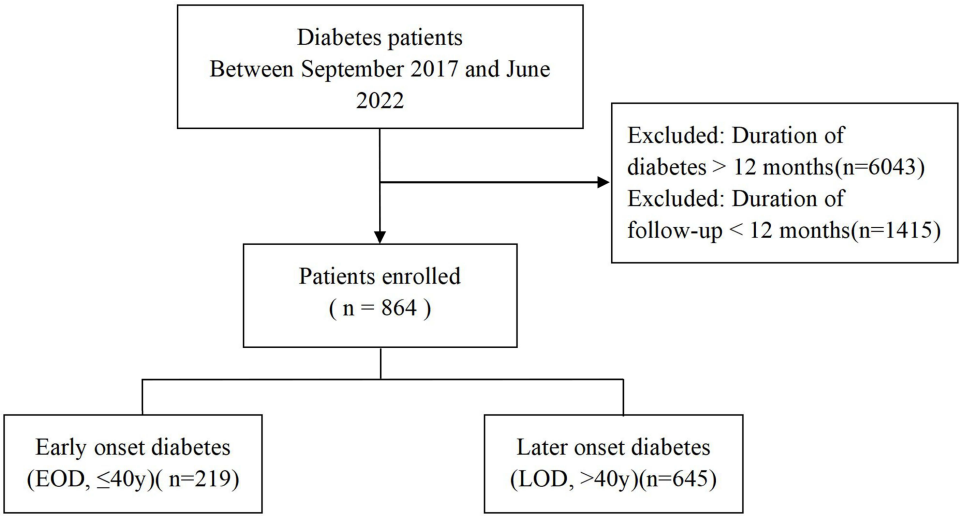

Figure 1 Flowchart of the study.

Study variables included in these analyses include age, sex, diabetes duration, family history of diabetes, smoking status, drinking status, use of antidiabetic medications, body weight, frequency of follow-up, body mass index (BMI), history of dyslipidemia, history of hypertension, and levels of triglycerides (TG), total cholesterol (TC), fasting C-peptide (FCp), fasting plasma glucose (FPG), systolic/diastolic blood pressure (SBP/DBP), glycated hemoglobin (HbA1c), and high-/low-density lipoprotein cholesterol (HDL-C/LDL-C), diabetes medication, physical activity, diet (fish, soybean-derived products, salt, vegetables and fruit), and sleep duration.

Statistical Analyses

Data are reported as medians (IQR) or numbers (%). Mann–Whitney *U*-tests and chi-square tests were respectively used to compare differences between groups for skewed continuous data and categorical data. When comparing baseline and follow-up data within the EOD and LOD groups, Wilcoxon signed-rank tests were used.

Multivariate linear regression analyses were employed when conducting between-group comparisons, evaluating the relationship between onset age and percentage changes in relevant clinical indices while adjusting for sex, BMI, SBP, TC, diabetes duration, HbA1c, frequency of follow-up, diabetes medication, physical activity, diet, and sleep duration.

Subgroup analyses were also conducted for patients stratified according to sex, SBP, TC, diabetes duration, HbA1c, frequency of follow-up, diabetes medication, physical activity, diet, and sleep duration, adjusting for all variables other than those used for stratification in these analyses. $P < 0.05$ was the significance threshold for this study. SPSS 23.0 and Free Statistics software version 2.0 was used to conduct statistical analyses.

Results

Participant Characteristics

This study ultimately enrolled 864 T2DM patients (Figure 1). These patients had a median (IQR) age of 49 (40.25, 57) years, 613 (70.9%) were male, and the median (IQR) age of diabetes onset was 49 (40, 57) years (Table 1).

Onset Age-Related Differences in Baseline Characteristics

The enrolled patients were next separated into EOD and LOD subgroups, using 40 years of age as a threshold to divide these groups. The respective median ages of the EOD and LOD patient subgroups were 34 and 52 years. When comparing these two groups at baseline, individuals in the EOD group were more likely to be male, to have a higher frequency of follow-up, and higher levels of antidiabetic medication use, together with lower odds of smoking and having a history of hypertension, in addition to exhibiting higher FBG, FCp, HbA1c, TG, BMI, body weight, and DBP

Table 1 Baseline MMC T2DM Patient Characteristics

	Total	EOD	LOD	P value
n	864	219	645	
Age(y)	49(40.25,57)	34(31,38)	53(47,59)	<0.001
Male,n(%)	613(70.9%)	181 (82.6%)	432 (67.0%)	<0.001
Onset age(y)	49(40,57)	34(31,38)	52(47,59)	<0.001
Duration of diabetes(m)	0(0,3)	0(0,3)	0(0,4)	0.133
History of hypertension,n(%)	310 (35.9%)	32 (14.6%)	278 (43.1%)	<0.001
History of dyslipidemia,n(%)	168 (19.4%)	44 (20.1%)	124 (19.2%)	0.78
Family history of diabetes,n(%)	376 (43.5%)	107 (48.9%)	269 (41.7%)	0.065
Smoking,n(%)	256 (29.6%)	84 (38.4%)	172 (26.7%)	0.001
Drinking,n(%)	144 (16.7%)	34 (15.5%)	110 (17.1%)	0.6
Follow-up frequency,n	3(3,4)	4(3,4)	3(3,4)	<0.001
Diabetes medication use,n(%)	632 (73.1%)	178 (81.3%)	454 (70.4%)	0.002
DBP(mm Hg)	77(71,84)	78(72,86)	77(70,84)	0.023
SBP(mm Hg)	128(119,139)	127(119,139)	129(118.5,140)	0.711
Body weight(kg)	70.2(61.825,80)	76.5(67,86.9)	68.5(60.55,77.6)	<0.001
BMI(kg/m^2)	25.60(23.44,28.13)	26.64(23.57,29.39)	25.47(23.32,27.69)	<0.001
FBG(mmol/L)	8.03(6.71,11.59)	8.92(6.5,12.8)	7.91(6.75,11.21)	0.165
FCp(μg/L)	2.29(1.62,3.02)	2.4(1.57,3.27)	2.27(1.64,2.81)	0.15
HbA1c(%)	8.5(6.8,10.7)	9.3(7.2,11.4)	8(6.8,10.4)	<0.001
TG(mmol/L)	1.58(1.09,2.50)	2.07(1.2,3.33)	1.47(1.05,2.27)	<0.001
TC(mmol/L)	5.14(4.39,5.98)	5.13(4.35,6)	5.15(4.40,5.97)	0.892
HDL-C(mmol/L)	1.09(0.93,1.3)	0.99(0.83,1.15)	1.13(0.97,1.34)	<0.001
LDL-C(mmol/L)	2.99(2.34,3.62)	2.97(2.29,3.6)	3(2.35,3.64)	0.635

Notes: Data are medians (IQR). Continuous (categorical) variables were compared at baseline between EOD and LOD patients with Mann–Whitney *U*-tests (chi-square tests).

Abbreviations: MMC, Metabolic Management Center; T2DM, type 2 diabetes mellitus; EOD, early-onset T2DM; LOD, late-onset T2DM; DBP, diastolic blood pressure; SBP, systolic blood pressure; BMI, body mass index; FPG, fasting plasma glucose; FCp, fasting C-peptide; HbA1c, glycosylated hemoglobin; TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

levels but lower HDL-C levels relative to LOD patients (all $P < 0.05$, Table 1). No significant differences between groups were observed for history of dyslipidemia, family history of diabetes, drinking status, SBP, TC, or LDL-C levels (Table 1). Moreover, there were no significant differences in physical activity, vegetables and fruit intake, fish intake, but a slightly differences in sleep duration, soybean-derived products intake, salt intake and diabetes medication were found between two groups (Supplementary Table 1).

Onset Age-Related Differences in Changes in Metabolic Parameters Relative to Baseline

After a 12-month follow-up interval, both groups exhibited improved metabolic parameters (Table 2). To compare these changes between the EOD and LOD groups, percentage changes relative to baseline were assessed on 1-year follow-up. Significantly improved glycemic control was evident in both groups, as evidenced by percentage change in HbA1C and FBG in the EOD (HbA1c: −28.49 (−44.26, −6.45); FBG: −23.35 (−45.85, 1.70); both $P < 0.001$) and LOD (HbA1c: −13.70 (−30.15, −1.60); FBG: −13.13 (−34.30, 2.25); both $P < 0.001$) groups (Table 2). Only EOD group patients, however, exhibited significant improvements in FCp, body weight, and BMI (Table 2). To explore the efficacy of different metabolic parameters in the LOD and EOD patient cohorts, analyses of between-group differences in percentage changes were conducted, revealing that the EOD group exhibited greater reductions in BP, BMI, HbA1c, TG, and TC levels relative to the LOD group (Table 3). After adjustment for confounders, the reductions in HbA1c levels is significantly greater in EOD patients than LOD patients (−28.49 (−44.26, −6.45)% vs −13.70 (−30.15,-1.60)%, $P = 0.017$) (Table 3 and Supplementary Table 2).

Table 2 Clinical Outcomes of Patient After 1-Year Follow-Up

	Total(n=864)		EOD(n=219)		LOD(n=645)	
	Follow-up	P value	Follow-up	P value	Follow-up	P value
DBP(mm Hg)	76(69,82)	<0.001	76(70,84)	<0.001	76(69,82)	<0.001
SBP(mm Hg)	127(118,137)	0.003	126(119,134)	0.015	128(117.5,137)	0.043
Body weight(kg)	70.2(61.9,79.58)	0.203	75.2(66.5,86)	0.006	68.3(60.85,77.5)	0.76
BMI(kg/m2)	25.59(23.39,28.07)	0.192	26.16(23.61,29.73)	0.008	25.42(23.28,27.69)	0.83
FBG(mmol/L)	6.67(5.89,7.94)	<0.001	6.5(5.72,7.83)	<0.001	6.69(5.96,7.95)	<0.001
FCp(μg/L)	2.29(1.7,3.07)	0.096	2.7(1.9,3.6)	<0.001	2.2(1.625,2.9)	0.539
HbA1c(%)	6.6(6,7.3)	<0.001	6.4(5.9,7.1)	<0.001	6.6(6.1,7.3)	<0.001
TG(mmol/L)	1.43(0.92,2.21)	<0.001	1.72(1.15,2.67)	<0.001	1.32(0.87,2.095)	<0.001
TC(mmol/L)	4.57(3.83,5.43)	<0.001	4.6(3.99,5.42)	<0.001	4.57(3.77,5.44)	<0.001
HDL-C(mmol/L)	1.13(0.97,1.36)	<0.001	1.07(0.92,1.27)	<0.001	1.14(1,1.4)	<0.001
LDL-C(mmol/L)	2.54(1.9,3.23)	<0.001	2.64(2.13,3.26)	<0.001	2.46(1.82,3.22)	<0.001

Notes: Changes are shown as median (IQR). P-values are based on comparisons of baseline and follow-up values in the EOD and LOD patients groups, and were analyzed with Wilcoxon signed-rank tests.

Abbreviations: EOD, early-onset T2DM; LOD, late-onset T2DM; DBP, diastolic blood pressure; SBP, systolic blood pressure; BMI, body mass index; FPG, fasting plasma glucose; FCp, fasting C-peptide; HbA1c, glycosylated hemoglobin; TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

Table 3 Metabolic Parameter Percentage Changes at 1-Year Follow-Up

	Total	EOD	LOD	P value
DBP(mm Hg)	−2.60(−10.26,5.63)	−3.61(−10.59,4.48)	−2.38(−10.11,6.37)	0.47
SBP(mm Hg)	−0.80(−7.89,6.03)	−1.64(−8.09,5.17)	−0.70(−7.83,6.54)	0.11
Body weight(kg)	−0.16(−3.76,3.06)	−0.65(−5.68,3.04)	0(−2.94,3.10)	0.064
BMI(kg/m^2)	−0.16(−3.76,3.06)	−0.65(−5.68,3.04)	0(−2.94,3.10)	0.064
FBG(mmol/L)	−14.78(−36.85,2.20)	−23.35(−45.85,1.70)	−13.13(−34.30,2.25)	0.255
FCp(μg/L)	1.1157(−17.47,23.90)	8.06(−12.90,46.77)	0(−18.46,20.78)	0.195
HbA1c(%)	−16.67(−35.55,-2.67)	−28.49(−44.26,-6.45)	−13.70(−30.15,-1.60)	0.017
TG(mmol/L)	−10.64(−37.42,22.58)	−16.67(−40,18.45)	−8.90(−36.48,24.09)	0.719
TC(mmol/L)	−8.32(−23.19,6.45)	−8.93(−21.05,6.12)	−8.22(−24.19,6.62)	0.318
HDL-C(mmol/L)	4.10(−9.52,21.32)	4.59(−6.67,28.92)	3.88(−11,18.94)	0.064
LDL-C(mmol/L)	−10.94(−33.17,10.33)	−8.20(−25.33,10.95)	−12(−36.17,9.91)	0.007

Notes: Metabolic parameters within groups are shown as median (interquartile range). P values for the between-group percentage changes were evaluated using multivariable linear regression models, adjusted for sex, follow-up frequency, BMI, SBP, HbA1c, TC, duration of diabetes, diabetes medication, physical activity, diet, and sleep duration.

Abbreviations: T2DM, type 2 diabetes mellitus; EOD, early-onset T2DM; LOD, late-onset T2DM; DBP, diastolic blood pressure; SBP, systolic blood pressure; BMI, body mass index; FPG, fasting plasma glucose; FCp, fasting C-peptide; HbA1c, glycosylated hemoglobin; TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

Onset Age-Related Differences in HbA1c Change in Specific Patient Subgroups

Given that certain baseline characteristics were found to be biased when comparing the enrolled EOD and LOD patient groups, these patients were additionally stratified according to specific characteristics after which fully adjusted multivariate linear regression analyses were performed. Differing results were evident when stratifying patients based on sex, BMI, HbA1c levels, frequency of follow-up. Specifically, significant differences in the percentage change in HbA1c were only detected between the LOD and EOD patient subsets among males, individuals with a BMI ≥ 25, individuals with HbA1c levels ≥ 9, and individuals with a follow-up frequency < 2 (Figure 2), whereas the same was not true in other subgroups.

Discussion

Our study showed that, independent of baseline diabetic control status, those with EOD exhibited significant improvements in a range of metabolic markers at 1-year follow-up compared to those with LOD. Subgroup analysis revealed that

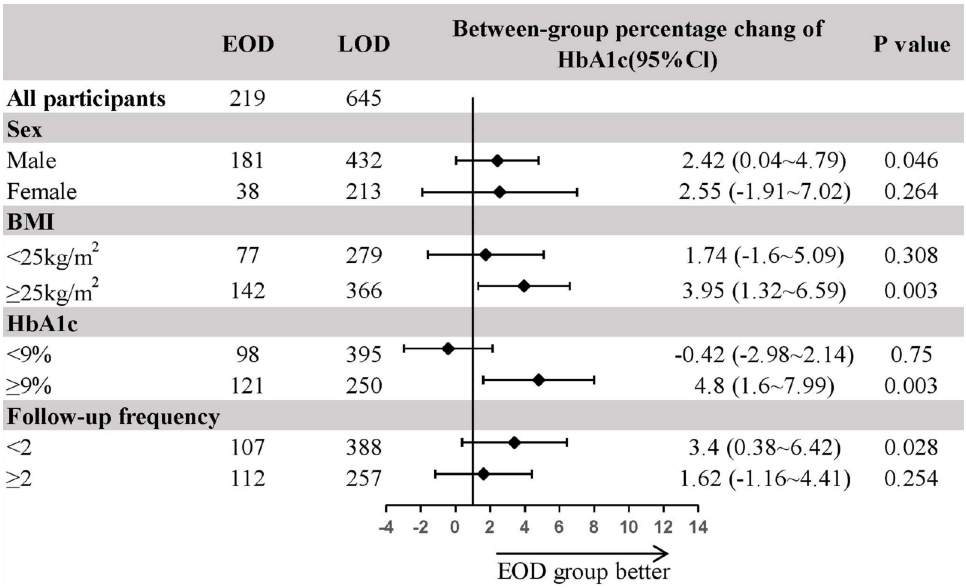

Figure 2 Subgroup analyses of the relationships between diabetes age of onset and percentage change in HbA1c. Results were adjusted for all of the following not used for stratification: sex, follow-up frequency, BMI, SBP, HbA1c, TC, diabetes duration, diabetes medication, physical activity, diet, and sleep duration.

participants in EOD with a high baseline HbA1c level (HbA1c ≥ 9%) experienced significantly greater benefits than those in LOD.

EOD patients exhibited worse waist circumference and BMI values than LOD patients in the present study, whereas FCp was comparable in these two groups, in line with prior results.[25,26] The MMC centers on the core idea of "one center, one one-stop service, one standard", the advanced diagnosis and treatment technology is combined with the Internet of Things management to provide one-stop diagnosis and treatment services for patients, and achieve a multi-benefit diagnosis and treatment model online and offline, inside and outside the hospital. The present study indicates that following a 1-year standardized MMC management period, both LOD and EOD patients exhibited significant improvements in levels of blood lipids and glucose. EOD patients also presented with significantly improved islet function and body weight. In other reports, MMC management has been linked to improvements in an array of metabolic parameters including weight, BMI, HbA1c, LDL-C, and HDL-C. These improved glycolipid metabolism parameters are attributable to the integrated approach to diabetes management employed by MMC, which includes health education, rational drug administration, lifestyle interventions, and routine supervision and follow-up. Those patients who received comprehensive early-stage treatments for DM and underwent standardized management exhibited improved prognoses, potentially delaying vascular complications and other adverse outcomes.

These data further revealed that EOD patients presented with greater improvements in FCp, DLD-C, blood pressure, HbA1c, and BMI relative to LOD patients. This may be because these patients have more access to diabetes-related information and a more comprehensive understanding of this disease in the information age such that they are more aware of disease control and self-management strategies, in addition to being more attentive to lifestyle interventions and follow-up. They may also be more likely to comply with provided medical advice. Improvements in weight loss and islet function can also facilitate superior glycemic control.

While males exhibited significant differences in the percentage HbA1c change when comparing the LOD and EOD groups, the same was not true for females. This may be because females of all ages exhibited better compliance and/or fewer negative lifestyle factors as compared to their male counterparts.[27–29] For example, a study in Canada found that female sex was related to better diabetes monitoring and clinical outcomes, including hospitalization rates, stroke incidence, and the prevalence of heart disease among diabetic patients.[30] Older males are also more likely to be resistant to changing poor living habits.[31] Unhealthy lifestyle factors are closely tied to the onset and progression of T2DM such that lifestyle changes are widely regarded as a key foundation for the treatment of this disease.

Among patients with higher baseline weight (BMI ≥ 25), EOD patients were able to achieve greater glycemic control than LOD patients. Obesity is well-established as a factor that can impact glycolipid metabolism, and losing weight can improve such metabolic activity, particularly with respect to glucose metabolism. EOD patients in this study presented with greater weight loss owing to the greater emphasis that is placed on weight loss for young patients. These younger individuals also presented with fewer comorbid diseases such that they were more likely to elect to use glucose-lowering drugs capable of reducing body weight including metformin, SGLT-2i, and glucagon-like peptide-1 (GLP-1) RA. A correlation has recently been reported between glycemic control and weight reductions among individuals with youth-onset T2DM.[32] The American Diabetes Association (ADA) Standards of Care highlight several benefits to weight management for T2DM patients,[33] and managing obesity has consistently been shown to slow the onset of T2DM in prediabetic individuals[34] while also helping to treat those patients who already have T2DM.[35,36] Among T2DM patients who are overweight or obese, a modest loss of weight can improve glycemic control and lower the requirement for glucose-lowering drugs, while greater degrees of weight loss can substantially decrease HbA1c and fasting glucose levels, promoting sustained T2DM remission for a minimum of 2 years.[37]

Notably, the subgroup analyses performed herein demonstrated that relative to LOD patients, those EOD patients with higher baseline HbA1c levels (≥ 9%) exhibited significantly greater benefits on 1-year follow-up. This may suggest that those patients with more effective glycemic control at baseline in both groups were already better-suited to self-management of their own blood glucose such that standardized management practices did not yield any significant differences between these groups. In contrast, younger individuals with poorer baseline self-management abilities attained greater benefits from standardized management efforts, potentially because they had become more aware of effective strategies such that they were more attentive to lifestyle interventions, timely follow-up, and adherence to medical advice as discussed above. Younger individuals exhibiting hyperglycemia are also more likely to undergo intensive therapy. Further research is need to conduct to explain this result. Meta-analyses have consistently demonstrated that higher HbA1c levels at baseline are predictive of greater changes in HbA1c levels with treatment, irrespective of the specific class of therapeutics utilized.[38] Prior real-world studies have also confirmed the utility of baseline HbA1c as a measure of glycemic response.[39]

In this study, the glycemic control of EOD patients with a lower follow-up frequency (< 2) was better than that of corresponding LOD patients, suggesting that patients with early-onset disease may be more attentive to the disease and better equipped to conduct self-management at home. The less frequent follow-up may also be due to the fact of more rapid improvement in glycemic control. In contrast, those EOD patients with a higher follow-up frequency in MMC achieved metabolic outcomes similar to those of LOD patients. As such, more frequent follow-up may limit the disadvantages and risks associated with reliance on self-management on other factors with respect to glycemic control. Indeed, another prospective multicenter real-world study has shown that a higher follow-up frequency (> 2 times/year) can benefit blood glucose control.[22]

These data emphasize the need for hierarchical management based on the baseline characteristics of individuals with T2DM, and the appropriate implementation of these practices has the potential to reduce the public health burden and need for long-term disease management among diabetic patients in China. Specifically, the present results emphasize the need for more frequent follow-up visits for patients who are older, male, obese, and with higher baseline HbA1c levels.

These results are subject to multiple limitations. For one, there were differences in patient characteristics between groups, and propensity score matching could not be implemented as it would have resulted in a drastic reduction in sample size. Secondly, while the results were adjusted for a variety of covariates, other potential residual confounding factors not taken into account may have also impacted these metabolic outcomes, such as income, education level, diet, and access to internet-based self-management support resources through the MMC platform. Third, as all patients were newly diagnosed and data were only available through the 1-year follow-up time point, only certain readouts and metabolic risk factors such as HbA1c, Bp, HDL-C, LDL-C, and TG could be assessed, whereas specific complications could not be evaluated. As such, additional long-term follow-up for these patients will be essential to expand on these results in the future.

Conclusion

In summary, based on data collected at the 1-year follow-up time point, a standardized metabolic disease management model can facilitate superior metabolic control in individuals with newly-diagnosed T2DM, particularly among EOD patients. Future efforts should center on efforts to diagnose and treat diabetes in its early stages, promoting the MMC model and stressing the need for integrated efforts to manage body weight, blood glucose, blood pressure, and blood lipids. To help the management of individuals with LOD, efforts to improve awareness and treatment compliance are also warranted.

Ethics Approval and Informed Consent

This study was approved by the institutional review board of The Second People's Hospital of Yuhuan and Taizhou Central Hospital (Taizhou University Hospital). This study was performed in accordance with the Declaration of Helsinki, and all study participants provided written informed consent.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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