Consequences of gestational diabetes mellitus on neonatal cardiovascular health: MySweetHeart Cohort study

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BACKGROUND: Hyperglycaemic disorders of pregnancy are associated with offspring cardiovascular alterations.

METHODS: MySweetHeart cohort study aimed to assess the effect of maternal gestational diabetes (GDM) on offsprings’ cardiovascular health. Newborns underwent clinical and echocardiographic examinations between 2016 and 2020.

RESULTS: Compared to mothers without GDM (n = 141), mothers with GDM (n = 123) were more likely to have had GDM in previous pregnancies and had higher weight, BMI, blood glucose, and HbA1c. Newborns of both groups showed similar clinical characteristics. Echocardiography was performed on the 3rd (interquartile range, IQR, 2nd–4th) day of life in 101 offsprings of mothers without and 116 offsprings of mothers with GDM. Left ventricular (LV) mass was similar. Children born to mothers with GDM had a thicker posterior LV wall (z-score +0.15, IQR −0.38/0.62, versus +0.47, IQR −0.11/1.1, p = 0.004), a smaller end-systolic (1.3 mL, IQR 1.0–1.5 mL, versus 1.4 mL, IQR 1.2–1.8 mL, p = 0.044) but a similar end-diastolic LV volume. They also had shorter tricuspid valve flow duration and aortic valve ejection time, lower tricuspid E-wave and pulmonary valve velocities.

CONCLUSIONS: Newborns of mothers with or without GDM had similar clinical characteristics and LV mass. However, some echocardiographic differences were detected, suggesting an altered myocardial physiology among infants of mothers with GDM.

REGISTRATION: ClinicalTrials.gov (NCT02872974).

Pediatric Research (2023) 94:231–238; https://doi.org/10.1038/s41390-022-02390-4

INTRODUCTION

Arteriosclerosis is the leading cause of death worldwide.1 Besides traditional cardiovascular risk factors such as arterial hypertension, smoking, hyperlipidemia, diabetes mellitus, obesity, sedentary lifestyle and genetic predisposition, fetal programming and conditioning have been shown to play a relevant role, tracking into adulthood.2–5

Maternal hyperglycaemic disorders during pregnancy are associated with fetal cardiovascular alterations.6 In addition to an increased risk of congenital heart anomalies and septal hypertrophy,7 typically described in the context of diabetes mellitus, more subtle changes can be found in the broader context of pregnancy hyperglycaemia. In fact, this latter might play a role in the fetal programming of obesity and metabolic disorders later in life.6,8,9

To investigate the possible role of gestational diabetes mellitus (GDM) on offsprings’ cardiovascular health early in life, the MySweetHeart Cohort study aimed at assessing surrogate markers of cardiovascular health and disease during fetal life and shortly after birth.6 In the present contribution, we report the results relating to clinical and echocardiographic newborns’ characteristics.

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Received: 23 March 2022 Revised: 8 October 2022 Accepted: 26 October 2022
Published online: 28 November 2022
METHODS

Study design and study population
MySweetHeart Cohort is a study, whose protocol has been previously described.\(^6\) Briefly, all pregnant women attending the antenatal care or the GDM clinics at the Lausanne University Hospital (CHUV), Switzerland, or being followed by a gynecologist in private practice in the “Canton de Vaud” (Switzerland), were invited to participate. Eligible were pregnant women 18 or more years of age at 24–32 gestational weeks. Women not understanding either French or English, on strict bed rest, with pre-existing diabetes mellitus, or with severe mental disorders were excluded. Informed consent was sought and obtained by all participant mothers.

Diagnosis of GDM was made according to international recommendations.\(^6,6^\) At each visit, data on maternal demographics, clinical and biochemical characteristics were collected, as described previously.\(^6\) Within 7 postnatal days, newborns were examined by an experienced pediatric cardiologist (blinded with respect to the maternal glycemic status) by means of a thorough clinical assessment and a complete echocardiographic study.

Echocardiography and measurements
Echocardiography was performed according to the recommendations of the American Society of Echocardiography\(^1\) on a Philips Epic 5 ultrasound system equipped with S8-3 and S12 MHz pediatric transducers. The following parameters were systematically assessed and transferred to a dedicated, anonymized database: (1) right (RA) and left atrial (LA) planimetered areas, measured from apical 4-chamber views;\(^1^1\) (2) Left ventricle (LV) size in both M-mode (short-axis) and 2D images, (3) LV function as estimated by means of fractional shortening (FS) in M-mode and ejection fraction (EF) according to the Simpson monoplane method; (4) flow measurements over atrioventricular and semilunar valves were taken with pulsed-wave, respectively continuous-wave Doppler, as appropriate; (5) diastolic function was assessed by means of mitral and tricuspid valves E-wave and A-wave measurements, E/A ratio and deceleration time, as well as aortic and pulmonary valve ejection times. Body surface area (BSA) was estimated by means of the Haycock method;\(^1^2\) left ventricular mass was estimated according to Devereux (LVM) and Reichek (LVM 2d) formulas\(^1^3,1^4\); left ventricular mass index (LVMI) was estimated applying the de Simone correction to the Devereux formula.\(^1^5\)

Statistical analysis
Data were tested for normality graphically and by means of the D’Agostino–Pearson test. Since several variables were non-normally distributed, for consistency, all continuous variables are presented as median and interquartile range (IQR), respectively as box plots, and were compared by means of the non-parametric Mann–Whitney U test for independent samples. Proportions are presented as absolute number and percentage and variables were compared by means of Fisher’s exact test. Statistical significance was assigned at \(p < 0.05\) (two-tailed). In a post-hoc analysis, we calculated the Spearman correlation coefficient \(r\) between maternal body mass index (BMI), maternal fasting plasma glucose, respectively maternal HbA1c and several infants’ echocardiographic characteristics. Statistical analysis was performed with GraphPad Prism 8.0 (GraphPad Software, Inc., San Diego, California). Power analysis had previously indicated that a sample size of \(n = 80\) per group would have been needed to detect a clinically significant difference in LVMI between the two groups and a conservative recruitment sample of \(n = 100\) pregnant women per group was aimed for.\(^6\)

RESULTS

Characteristics of the study population
Between September 1, 2016, and October 24, 2020, 264 mothers with their newborn infants were included. Median maternal age was 33 (IQR 30–36) years, without significant differences between mothers with and without gestational diabetes. While no significant difference in language and education was detected, mothers with gestational diabetes were more likely to have smoked (\(p < 0.0001\)) or drunk (\(p = 0.0239\)) during pregnancy, to have already had gestational diabetes in previous pregnancies (\(p < 0.0001\)), to have a family history of diabetes mellitus (\(p = 0.0001\)), or to have a history of arterial hypertension (\(p = 0.0197\)). Interestingly, also a paternal family history of diabetes mellitus was more frequent (\(p = 0.0037\)) among children whose mothers had GDM (Table 1). Unsurprisingly, mothers with gestational diabetes were of higher weight (\(p < 0.0001\)) and BMI (\(p < 0.0001\)) and, as per definition, presented higher (\(p < 0.0001\)) blood glucose (both with void stomach and upon oral glucose provocation testing) and HbA1c (Table 1, \(p < 0.0001\)).

Newborns issued from mothers with and without gestational diabetes did not show any significant difference in their baseline clinical characteristics (Table 2).

Echocardiographic measurements at birth
Echocardiographic measurements were available for 217 (82%) out of the 264 included children, of which 101 were among children born to mothers without and 116 among children born to mothers with GDM (Table 3), and were performed in median on the 3rd (IQR 2nd–4th) day of life. Both M-mode measurements and LVM estimations were available for at least 202 (93%) children, while a complete echocardiographic set of measures was obtained in at least 185 (85%) participants.

As per the primary outcome, there was no significant difference in estimated LVM in children born to mothers with and without gestational diabetes, irrespective of which formula was used to echocardiographically estimate LVM (Table 3) and of whether the absolute mass or the indexed value was considered (Fig. 1).

Although most echocardiographic parameters were similar while comparing the two groups, there were a few significant differences. Children born to mothers with gestational diabetes had a thicker posterior LV wall, as assessed by z-scores (+0.15, IQR 0.38–0.62, versus +0.47, IQR −0.11/−1.1, \(p = 0.0041\)), while the comparison was not significant when the LV posterior wall was simply assessed as an absolute dimension (Fig. 2). While the end-diastolic volume was not significantly different, the end-systolic LV volume was (Fig. 3), with control children presenting a slightly, but significantly higher end-systolic LV volume (1.4, IQR 1.2–1.8 mL) than children issued from a pregnancy characterized by gestational diabetes (1.3, IQR 1.0–1.5 mL, \(p = 0.0437\)). Aortic valve ejection time and pulmonary valve maximal velocity were minimally, but significantly, smaller among children born to mothers with gestational diabetes than without (Table 3). Both tricuspid valve E-wave and tricuspid valve flow duration were minimally but significantly higher, respectively longer, among controls than among children born to mothers with gestational diabetes (Table 3).

Maternal BMI was weakly but significantly associated with LV-EF (\(r = 0.1429, 95\%\) confidence interval −0.01701 to 0.2817, \(p = 0.0462\)), LVM as calculated with the Reichek formula (\(r = 0.1785, 95\%\) confidence interval 0.03670–0.3133, \(p = 0.0114\)) and the mitral valve E/A ratio (\(r = -0.1752, 95\%\) confidence interval −0.3119 to −0.03142, \(p = 0.0143\)). No significant correlation between BMI and the other considered echocardiographic parameters was detected. Maternal fasting plasma glucose level was not significantly associated with any echocardiographic parameter. Maternal HbA1c was significantly associated with LV posterior wall diameter (\(r = 0.1681, 95\%\) confidence interval 0.01928–0.3096, \(p = 0.0229\)) and LV posterior wall z-score (0.2387, 95% confidence interval 0.08559–0.3808, \(p = 0.0019\)), without any further significant correlation between HbA1c and the remaining echocardiographic parameters.

DISCUSSION

The present study was able to analyze 123 mother-infant diads with gestational diabetes compared to 141 diads without, and delivered three main results. (1) Although clinical characteristics of mothers were different between groups, those of infants were comparable. (2) Contrary to what we expected, the estimated left ventricular mass and mass index were not different among children issued from pregnancies with or without gestational
Table 1. Characteristics of study participants (mothers and fathers) with and without gestational diabetes.

| Maternal demographic characteristics                                      | Without GDM (N = 141) | With GDM (N = 123) | p value |
|---------------------------------------------------------------------------|------------------------|---------------------|---------|
| Speaks French (y:n)                                                      | 118:22                 | 108:10              | ns      |
| Maternal education                                                       |                         |                     |         |
| No scholarity                                                             | 0                      | 1                   | ns      |
| Primary school                                                            | 13                     | 9                   |         |
| Professional training                                                    | 25                     | 23                  |         |
| Maturity                                                                  | 18                     | 14                  |         |
| University                                                                | 81                     | 52                  |         |
| No answer                                                                 | 4                      | 24                  |         |
| General health: previous health problems (y/n)                           | 63:68                  | 49:38               | ns      |
| Previous GDM (y:n)                                                       | 0:136                  | 17:44               | < 0.0001|
| Family history of DM (maternal family) (y:n)                             | 60:77                  | 78:36               | = 0.0001|
| Family history of DM (paternal family) (y:n)                             | 23:113                 | 34:68               | = 0.0037|
| Father with DM (y:n)                                                     | 1:133                  | 3:104               |         |
| Maternal history of arterial HTN                                         | 0:135                  | 3:48                | 0.0197  |
| Maternal history of PCOS                                                 | 0:135                  | 1:46                |         |
| Maternal history of (previous) macrosomia                                | 4:132                  | 3:43                |         |
| Smoking (during pregnancy) (y:n)                                         | 5:135                  | 22:93               | < 0.0001|
| Drinking during pregnancy                                                | 1:138                  | 7:105               | = 0.0239|
| Recreational drugs during pregnancy                                      | 1:136                  | 3:107               |         |
| Maternal clinical characteristics                                         | (N)                    | (N)                 |         |
| Age                                                                       | 33 [30–35]             | 33 [30–36]          | ns      |
| Parity (nulliparous: non-nulliparous)                                    | 78:62                  | 58:60               |         |
| Body weight [kg]                                                         | 59.6 [54.5–66.0]       | 66.5 [58.0–76.3]    | < 0.0001|
| Height [m]                                                                | 1.65 [1.60–1.70]       | 1.63 [1.60–1.68]    | ns      |
| BMI (kg/m²)                                                              | 21.8 [20.0–24.5]       | 24.8 [21.8–28.1]    | < 0.0001|
| Glucose void stomach [mmol/L]                                            | 4.5 [4.3–4.8]          | 5.1 [4.8–5.4]       | < 0.0001|
| Glucose 1 h post-challenge [mmol/L]                                      | 6.9 [6.0–8.3]          | 10.2 [8.4–11.0]     | < 0.0001|
| Glucose 2 h post-challenge [mmol/L]                                      | 6.0 [4.2–6.8]          | 8.2 [6.8–9.2]       | < 0.0001|
| HbA1c [%]                                                                | 4.8 [4.7–5.1]          | 5.2 [5.0–5.4]       | < 0.0001|

BMI body mass index, DM diabetes mellitus, GDM gestational diabetes mellitus, HbA1c glycated hemoglobin, HTN hypertension, n no, PCOS polycystic ovary syndrome, y yes.

Table 2. Clinical characteristics of participant newborns issued from mothers with and without gestational diabetes.

| Infant clinical characteristics                                      | Without GDM (N = 141) | With GDM (N = 123) | p value |
|---------------------------------------------------------------------|------------------------|---------------------|---------|
| Delivery mode                                                       | ns                     |                     |         |
| Vaginal                                                             | 104                    | 78                  |         |
| Cesarean section                                                    | 28                     | 36                  |         |
| Unknown                                                             | 4                      | 3                   |         |
| Age at echocardiography [days]                                      | 3 [2–5]                | 3 [2–4]             | ns      |
| Weight at echocardiography [kg]                                     | 3.2 [2.9–3.6]          | 3.3 [3.1–3.6]       | ns      |
| Height at echocardiography [cm]                                     | 50 [48–51]             | 50 [48–51]          | ns      |
| BSA at echocardiography [m²]                                        | 0.20 [0.20–0.21]       | 0.20 [0.19–0.21]    | ns      |
| Sex (M:F)                                                           | 73:68                  | 65:58               | ns      |
| SBP [mmHg]                                                          | 78 [72–84]             | 77 [71–83]          | ns      |
| DBP [mmHg]                                                          | 46 [40–52]             | 47 [41–55]          | ns      |
| Heart rate [/min]                                                   | 126 [112–144]          | 122 [108–136]       | ns      |

BSA body surface area, DBP diastolic blood pressure, F female, M male, SBP systolic blood pressure.
diabetes. (3) However, some trivial but significant differences were found in a few echocardiographic parameters: infants born to mothers with gestational diabetes had a thicker posterior LV wall, smaller end-systolic left ventricular volume, shorter tricuspid valve flow duration and aortic valve ejection time, lower tricuspid E-wave and pulmonary valve maximal velocities.

These results represent novel knowledge. The differences being minimal, it is difficult to imagine an immediate clinical impact of this study. However, this data bears significant scientific interest and suggests that, although morphological differences are limited, distinctive functional variations can be detected in children born to mothers with gestational diabetes. Considering the important burden of cardiovascular disease over a lifetime course, the potential impact of better understanding these phenomena is relevant.

While interpreting the results, six considerations deserve discussion. First, the differences in baseline clinical and biochemical characteristics of mothers with and without gestational diabetes are all but surprising, and partly simply reflect the definition of this condition. Second, the fact that no significant clinical differences were detected among infants, including similar weight, height, BSA, and blood pressure, might apparently be

Table 3. Echocardiographic characteristics of participant newborns issued from mothers with and without gestational diabetes.

| Without GDM | With GDM | p value |
|-------------|----------|---------|
| n = 101     | n = 116  |         |
| Anatomy abnormal | ns |         |
| PFO/ASD | 1 | 3 |
| PDA | 1 | 4 |
| VSD | 0 | 5 |
| SVC abnormality | 0 | 1 |
| LV-FS [%] | 38 [33–42] | 38 [33–43] | ns |
| LV-EF (Simpson monoplan) [%] | 65 [59–72] | 68 [62–73] | ns |
| TAPSE [mm] | 9.0 [8.1–10.0] | 8.9 [8.0–9.8] | ns |
| IVS [mm] | 3.5 [3.2–4.0] | 3.6 [3.1–4.1] | ns |
| IVS [z-score] | −0.27 [−0.64/+0.15] | −0.10 [−0.73/+0.48] | ns |
| LVEDd [mm] | 18 [16–19] | 18 [17–19] | ns |
| LVEDd [z-score] | −0.40 [−0.72/+0.01] | −0.44 [−0.92−0.14] | ns |
| LVESd [mm] | 11 [9.8–12] | 11 [9.7–12] | ns |
| LVESd [z-score] | −0.31 [−0.63/+0.14] | −0.38 [−0.90/+0.11] | ns |
| PWD [mm] | 3.1 [2.7–3.5] | 3.2 [2.9–3.7] | ns |
| PWD [z-score] | 0.15 [−0.38/+0.62] | 0.47 [−0.11/+1.1] | p = 0.0041 |
| LVM 2D (Reichek) [g] | 7.2 [6.5–8.3] | 7.6 [6.6–8.5] | ns |
| LVM (Devereux) [g] | 7.9 [6.6–9.0] | 7.8 [6.7–9.3] | ns |
| LVMi (de Simone G) [g/m²] | 51.6 [46.1–59.5] | 51.0 [45.7–59.6] | ns |
| RA area [cm²] | 2.4 [1.9–2.5] | 2.1 [1.9–2.5] | ns |
| LA area [cm²] | 1.8 [1.6–2.2] | 2.0 [1.7–2.2] | ns |
| LV ED-Vol [mL] | 4.4 [3.5–5.3] | 4.0 [3.4–4.8] | ns |
| LV ES-Vol [mL] | 1.4 [1.2–1.8] | 1.3 [1.0–1.5] | p = 0.0437 |
| Vmax AoV [cm/s] | 81 [72–93] | 83 [72–93] | ns |
| Ejection time AoV [s] | 0.20 [0.19–0.21] | 0.20 [0.18–0.21] | p = 0.0282 |
| Vmax PulmV [cm/s] | 88 [75–101] | 82 [71–90] | p = 0.015 |
| Ejection time PulmV [s] | 0.22 [0.20–0.24] | 0.22 [0.20–0.24] | ns |
| MV E [cm/s] | 55 [46–64] | 55 [47–63] | ns |
| MV A [cm/s] | 52 [44–61] | 52 [44–60] | ns |
| MV E/A ratio | 1.00 [0.84–1.26] | 1.08 [0.88–1.22] | ns |
| MV flow duration [s] | 0.25 [0.24–0.27] | 0.25 [0.23–0.27] | ns |
| MV Deceleration time [s] | 0.11 [0.09–0.13] | 0.11 [0.09–0.13] | ns |
| TV E [cm/s] | 50 [43–59] | 46 [37–55] | p = 0.0258 |
| TV A [cm/s] | 57 [51–64] | 55 [49–64] | ns |
| TV E/A ratio | 0.86 [0.72–1.04] | 0.80 [0.69–1.05] | ns |
| TV flow duration [s] | 0.26 [0.24–0.29] | 0.26 [0.24–0.27] | p = 0.0486 |
| TV Deceleration time [s] | 0.12 [0.09–0.15] | 0.11 [0.09–0.14] | ns |

AoV aortic valve, ASD atrial septal defect, BSA body surface area, GDM gestational diabetes mellitus, LA left atrium, LV left ventricle, LV-EF left ventricle ejection fraction, LV-FS left ventricle fractional shortening, LVM left ventricular mass, LVMi left ventricular mass index, MV mitral valve, PFO patent foramen ovale, PulmV pulmonary valve, RA right atrium, RV right ventricle, SVC superior vena cava, TAPSE tricuspid annular plane systolic excursion, TV mitral valve, Vmax instantaneous maximal velocity, VSD ventricular septal defect.
surprising. However, this study was observational. This implies that mothers with gestational diabetes were managed as per clinical routine and all efforts were made to achieve normal glycemic control throughout the pregnancy. Third, this same consideration might explain the absence of significant difference in estimated left ventricular mass and mass index while comparing infants of the two groups (i.e., the primary outcome). Fourth, both the higher posterior left ventricular wall and the smaller end-systolic left ventricular volume in infants issued from pregnancies with gestational diabetes might suggest some minimal difference towards increased myocardial substance (even if not already reflected in significant estimated mass increase). It is tempting to assume that the careful clinical management was able to avoid macrosomia and left ventricular hypertrophy, but not to abolish any more subtle difference in myocardial structure and thickness. Fifth, the shorter tricuspid valve flow duration and aortic valve ejection time, as well as the lower tricuspid E-wave and pulmonary valve maximal velocities in infants born to mothers with gestational diabetes are tricky to interpret. A shorter tricuspid valve flow duration and lower E-wave velocity might suggest a more pronounced diastolic filling impairment of the right ventricle in infants born to mothers with gestational diabetes, but it is surprising that this difference was not detected while analyzing the mitral valve inflow into the LV. Furthermore, both tricuspid wave E/A ratio and deceleration time, which are further right ventricular diastolic function parameters, were not different among groups. The shorter aortic valve ejection time might suggest an increased systemic vascular resistance, but this was unfortunately not measured, so we cannot either prove or reject this hypothesis. The lower pulmonary valve maximal velocity in infants issued from a pregnancy with gestational diabetes remains without sensible physiological explanation. Finally, the post-hoc

Fig. 1  Box plots of the estimated left ventricular mass and mass index. Box plots of the estimated left ventricular mass (LVM, a) for children born to mothers with and without gestational diabetes, as calculated by the Devereux formula. No significant difference between the two groups was detected. Similarly (b), no significant difference was detected while comparing the left ventricular mass index (LVMI), as calculated by the de Simone formula.

Fig. 2  Box plots of posterior left ventricular wall thickness (PWd). The posterior left ventricular wall thickness (PWd) was similar in children born to mothers with (3.2, IQR 2.9–3.7 mm) or without (3.1, IQR 2.7–3.5 mm; \(p = 0.093\)) gestational diabetes when assessed as absolute dimension (a). However, it was slightly but significantly higher in children born to mothers with gestational diabetes (+0.47, IQR –0.11 to +1.1) than without (+0.15, IQR 0.38 to +0.62; \(p = 0.004\)) when normalized and assessed as z-scores (b).
Maternal HbA1c was positively correlated with LV diastolic diameter (LV-dia), as assessed by a negative correlation with the mitral inflow E/A ratio. Interestingly, while maternal fasting plasma glucose was not correlated with any infant echocardiographic parameter, maternal HbA1c was positively correlated with LV posterior wall thickness. In summary, although explorative and not adequately powered, correlation analysis was in line with the global interpretation of the main results: some weak association maternal glycaemia are far beyond myocardial structure. In fact, they may impact fetal brain activity and appetite regulation, programming future nutritional behavior.25 These aspects were not investigated in the current study. Fifth, no biochemical data (e.g., plasma glucose and prevalence of hypoglycaemia, growth hormone, insulin-like growth factor 1, Ca2+, Mg2+, etc.) of included newborns were collected. Finally, this was a cross-sectional analysis, and no follow-up measurements are currently available. In fact, some consequences of the exposure to maternal diabetes mellitus or gestational diabetes might manifest (only) later in life.26–29 For example, according to a recent meta-analysis, children born to mothers with gestational diabetes had increased systolic blood pressure (measured at the age of 3–16 years), BMI (measured at the age of 3–15 years) and serum glucose (measured at 8–27 years of age),30 so that medium and long-term follow-up studies are warranted, even in the absence of significant differences short after birth. Notably, in a study among 99 offspring of diabetic mothers and 422 controls, children born to mothers with gestational diabetes showed a decreased adiponectin and an increased leptin at 6–13 years of age,22 while in a similar study no difference was detected at 1 year of age.31

In conclusion, while comparing newborns issued from pregnancies with and without gestational diabetes, this study showed no difference either in infant baseline clinical characteristics or in their echocardiographically estimated LVM. However, some minor echocardiographic differences were detected, suggesting that myocardial physiology may be altered in these infants. Further studies should investigate the endothelial function of this population and the cardiovascular evolution of these children over time.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. GBD 2016 Causes of Death Collaborators. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 390, 1151–1210 (2017).
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