Concordance of glycaemic and cardiometabolic traits between Indian women with history of gestational diabetes mellitus and their spouses: an opportunity to target the household

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Abstract

Aims/hypothesis The aim of this study was to investigate the concordance of dysglycaemia (prediabetes or diabetes) and cardiometabolic traits between women with a history of gestational diabetes mellitus (GDM) and their spouses.

Methods Using hospital medical records, women with GDM (diagnosed between 2012 and 2016) and their spouses were invited to participate in the study and to attend a scheduled hospital visit in a fasting state. Sociodemographic, anthropometric and medical data were collected, and a 75 g OGTT with serum insulin estimation, HbA_{1c} measurement and fasting lipid profile were performed at the visit. Prediabetes and diabetes were defined using ADA criteria and the metabolic syndrome was defined using IDF criteria.

Results A total of 214 couples participated in the study. Women were tested at a mean $\pm$ SD age of 32.4 ± 4.6 years and median (quartile [q]25–q75) of 19.5 (11–44) months following the index delivery, while men were tested at a mean $\pm$ SD age of 36.4 ± 5.4 years. A total of 72 (33.6%) couples showed concordance for dysglycaemia, while 99 (46.3%) and 51 (23.8%) couples were concordant for overweight/obesity and the metabolic syndrome, respectively. A total of 146 (68.2%) couples showed concordance for any of the above three factors. The presence of dysglycaemia in one partner was associated with an increased risk of dysglycaemia in the other partner (OR 1.80 [95% CI 1.04, 3.11]). Similarly, being overweight/obese (OR 2.19 [95% CI 1.22, 3.93]) and presence of the metabolic syndrome (OR 2.01 [95% CI 1.16, 3.50]) in one partner was associated with an increased risk of these conditions in the other partner. Both women and men were more likely to have dysglycaemia if they had a partner with dysglycaemia. Women with a partner with dysglycaemia had a significantly higher BMI, waist circumference and diastolic BP, and a significantly higher probability of low HDL-cholesterol (<1.29 mmol/l) and the metabolic syndrome compared with women with a normoglycaemic partner. No such differences were observed for men with or without a partner with dysglycaemia.

Conclusions/interpretation The high degree of spousal concordance found in this study suggests social clustering of glycaemic and cardiometabolic traits among biologically unrelated individuals. This provides us with an opportunity to target the behavioural interventions at the level of the ‘married couple’, which may be a novel and cost-effective method of combating the current diabetes epidemic.

Keywords Cardiometabolic traits · Dysglycaemia · Gestational diabetes mellitus · India · South Asian · Spousal concordance · Spouse · Type 2 diabetes

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Research in context

What is already known about this subject?

- Women with gestational diabetes mellitus are at increased risk of future type 2 diabetes, which can be delayed or prevented by timely lifestyle interventions
- Intervention studies in these high-risk women have faced challenges of poor participant recruitment and retention for long-term follow up
- The inclusion of spouses together with women may help to improve participation rates in such studies

What is the key question?

- What is the concordance of glycaemic and cardiometabolic traits between women with a history of gestational diabetes and their spouses, and how do these various traits interact between the partners?

What are the new findings?

- We found a high degree of concordance for glycaemic and cardiometabolic traits between women with a history of gestational diabetes and their spouses
- The presence of a high-risk metabolic condition in one partner was associated with an increased risk of the same in the other partner

How might this impact on clinical practice in the foreseeable future?

- The high degree of spousal concordance suggests the need for family intervention trials that involve the spouse as a target of interventions and not merely as a supportive partner

Abbreviations

GDM	Gestational diabetes mellitus
IADPSG	International Association of Diabetes and Pregnancy Study Groups

Introduction

Gestational diabetes mellitus (GDM) is defined as hyperglycaemia with onset or recognition for the first time during pregnancy, and that is not overt diabetes. GDM is a significant public health problem, affecting about one in every four pregnancies in South East Asia according to IDF estimates [1]. This compares with global estimates of one in every six pregnancies [1]. Women with history of previous GDM are at eightfold higher risk for conversion to type 2 diabetes according to the results of a recent meta-analysis [2]. This risk is further amplified in women of South Asian ethnicity compared with other ethnicities [3]. Studies from India have reported high postpartum conversion rates to prediabetes or type 2 diabetes within 5 years after the index delivery [4–8].

There is evidence to suggest that the development of type 2 diabetes can be prevented or delayed by timely lifestyle interventions in such women [9]. However, challenges with respect to participant recruitment and retention for long-term follow-up are likely to be faced by intervention studies [10–13]. In a qualitative study, Dasgupta et al investigated strategies to optimise participation in diabetes prevention

programmes following GDM [14]. The researchers found that spousal inclusion may act as a positive factor in enhancing the participation of women in such programmes, possibly as a result of enhanced support for behavioural changes at home. Since the members of a family share a common environment, and behavioural factors (such as eating patterns and physical activity) tend to cluster among the members of the same household, it is important to plan intervention strategies keeping the entire family in context. In a retrospective cohort analysis, it was found that the incidence of diabetes was 33% higher in men who had a partner with a history of GDM compared with men whose partner did not have a history of GDM [15].

With this background, we undertook the present study with the objective of studying the concordance of glycaemic and cardiometabolic traits between South Asian women with a history of previous GDM and their spouses. The data from our study may help in providing a framework for planning family intervention trials in the near future, as was also highlighted by experts participating in a recent Danish Diabetes Academy symposium [16].

Methods

Settings and study design This was a cross-sectional study, performed from January 2016 to October 2017 at a tertiary care centre in North India (All India Institute of Medical

Sciences, New Delhi). The study was approved by the institutional ethics committee and written informed consent was obtained from all participants.

Inclusion and exclusion criteria We included women diagnosed with GDM as per the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria during 2012–2016, who were at least 6 weeks postpartum and were willing to come with their spouses for participation in the study. GDM by IADPSG criteria was defined as the presence of any one of three abnormal values (≥ 5.1 , 10.0 or 8.5 mmol/l at 0, 1 and 2 h, respectively) on a 75 g OGTT performed in a fasting state during pregnancy. Exclusion criteria included any hyperglycaemia during pregnancy other than GDM, such as overt diabetes in pregnancy or pre-existing diabetes mellitus, and current pregnancy. Women who could not participate with their spouses were also excluded.

Participant identification and recruitment Using medical records from the hospital records section of the tertiary care centre, women who were labelled as hyperglycaemic during pregnancy from 2012 to 2016 ($n = 961$) were identified, of whom 859 (89.4%) satisfied the diagnosis of GDM by the IADPSG criteria. A total of 850 (99.0%) women fulfilled the study inclusion criteria, of whom 546 (64.2%) could be contacted by telephone (maximum of three telephone calls) for participation in the study along with their spouses. Of these, 214 (39.2%) women agreed to participate in the study along with their spouses.

Procedure on the day of testing Couples were invited to attend the centre in a fasting state (minimum fast of 10 h) at 08:30 h. For participants observing prolonged fasts for religious reasons (e.g., Ramadan, Navratra), the visit was scheduled a week after the fast was over to allow for resumption of a normal diet. At the scheduled visit, a detailed questionnaire was completed for each participant, documenting demographic details, education and employment status, family history of diabetes mellitus and insulin/oral glucose-lowering drug use during the index pregnancy. A joint family was defined as a household where the study couple and their children lived, along with other related family members. A nuclear family was defined as a household where only the study couple and their children lived together.

Measurements Weight, height and waist circumference were recorded in a fasting state using standard methods (see [electronic supplementary material](#) [ESM] Methods). A mean of three BP readings was recorded. A 75 g OGTT with measurement of plasma glucose and serum insulin at 0, 30 and 120 min was performed using 83.3 g glucose monohydrate (equivalent to 75 g anhydrous glucose) dissolved in 300 ml water and consumed over 5–10 min. The time from the first

sip of the glucose solution was counted for 30 and 120 min sampling. Blood was also collected for a lipid profile and HbA_{1c} measurement in the fasting state.

Serum total cholesterol, triacylglycerol and HDL-cholesterol levels were measured directly using an enzymatic colorimetric method with commercially available kits using an automated biochemistry analyser (Cobas Integra 400 plus; Roche Diagnostics, Mannheim, Germany). LDL-cholesterol was calculated using the Friedewald equation except in participants with serum triacylglycerol ≥ 4.5 mmol/l, when a direct estimation was made. Serum insulin estimation was performed using an electrochemiluminescent tracer-based immunometric assay (sandwich assay) using a Cobas e411 auto-analyser (Roche Diagnostics). For plasma glucose, samples were collected in a fluoride vial, centrifuged immediately and transported to the laboratory within 1 h of collection in cool boxes. Glucose was analysed using the hexokinase method with the Cobas Integra 400 plus auto-analyser (Roche Diagnostics). Blood for HbA_{1c} was collected in EDTA vials and measured by HPLC-based ion-exchange chromatography (D-10 Hemoglobin A1c Program; Bio-Rad Laboratories, Hercules, CA, USA).

Definitions Individuals were classified as having normoglycaemia (fasting plasma glucose < 5.6 mmol/l, 2 h plasma glucose < 7.8 mmol/l and HbA_{1c} < 39 mmol/mol [5.7%]), prediabetes (fasting plasma glucose 5.6–6.9 mmol/l and/or 2 h plasma glucose 7.8–11.0 mmol/l and/or HbA_{1c} 39–47 mmol/mol [5.7–6.4%]) or diabetes mellitus (fasting plasma glucose ≥ 7.0 mmol/l and/or 2 h plasma glucose ≥ 11.1 mmol/l and/or HbA_{1c} ≥ 48 mmol/mol [6.5%]) as per ADA criteria [17]. For the diagnosis of diabetes mellitus, if only one value was abnormal then the test was repeated on another day to confirm the diagnosis. Participants with prediabetes or diabetes were labelled as having dysglycaemia. In women tested between 6 and 12 weeks postpartum ($n = 4$), only OGTT values were used to classify prediabetes and diabetes, as per ADA recommendations [17]. The metabolic syndrome was defined as per the IDF criteria: waist circumference ≥ 80 cm for women or ≥ 90 cm for men, plus two of the following: serum triacylglycerols ≥ 1.7 mmol/l, fasting plasma glucose ≥ 5.6 mmol/l, HDL-cholesterol < 1.29 mmol/l for women or < 1.03 mmol/l for men and BP $\geq 130/85$ mmHg [18]. Overweight and obesity were defined as BMI 25–29.9 and ≥ 30 kg/m², respectively (WHO international classification) [19]. The WHO definition was used primarily for analysis; however, additional data are presented using a BMI cut-off of ≥ 23 kg/m² (proposed as a potential public health action point for Asian populations) [20].

Insulin index calculations Insulin resistance was measured by HOMA using the standard formula [21, 22]. Insulin sensitivity was measured by the insulinogenic index using the formula

$\Delta I_{0-30} / \Delta G_{0-30}$ and composite beta cell function was measured by the oral disposition index using the formula: $\Delta I_{0-30} / \Delta G_{0-30} \times 1/\text{fasting insulin}$ (where ΔI_{0-30} is the change in serum insulin over 30 min [pmol/l] and ΔG_{0-30} is the change in plasma glucose over 30 min [mmol/l]) [23]. Negative insulinogenic and disposition index results because of a negative insulin or glucose response and positive results from combined negative insulin and glucose responses were excluded ($n = 9/413$, 2.2%) [24].

Statistical analysis Statistical analyses were carried out using Stata 12.0 (Stata Corp, College Station, TX, USA). Data are presented as n (%), mean $\pm$ SD or median (quartile [q]25–q75), as appropriate. Qualitative variables were compared between the groups using Pearson χ^2 test or Fisher's exact test. Quantitative variables were assessed for normality using the Shapiro–Wilk test. Variables with a normal distribution were compared using Student's t test for independent samples, and those that did not follow a normal distribution (i.e., triacylglycerol, HOMA-IR, insulinogenic index, disposition index) compared using the Wilcoxon rank-sum test.

To find the association of a metabolic variable of one member of the spousal pair with the corresponding metabolic variable of the other member of the spousal pair, logistic regression analysis was carried out. For models evaluating a husband's outcomes, factors considered were the wife's metabolic variables (i.e. dysglycaemia, being overweight/obese and the metabolic syndrome [exposure]) and the husband's variables ('other'), such as age ($<35/\geq 35$ years), family history of diabetes mellitus (no/yes), education (less than graduate/graduate and above), occupation (not employed/employed), marriage duration ($<8/\geq 8$ years) and family structure (joint/nuclear). For models evaluating a wife's outcomes, an additional factor considered was insulin use during the index pregnancy. These covariates were selected for the analysis because they represent non-modifiable risk factors for dysglycaemia (age and family history of diabetes), socioeconomic status (education and employment), severity of the glycaemic state in pregnancy (insulin use during

pregnancy), time spent by the married couple together (time since marriage; 8 years being the median time since marriage in this cohort) and influence of other family members (family structure). Since the ADA recommends screening for diabetes at age ≥ 45 years and diabetes is known to occur a decade earlier in the Indian population, a cut-off of 35 years was used for the covariate of age [25, 26]. The 'other' variables were assessed for effect modification and confounding using the Mantel–Haenszel test [27]. All covariates were found to be effect modifiers except for the covariate 'age', which was found to be a confounder in the analysis evaluating husbands' dysglycaemia. Both crude and adjusted ORs (95% CI) were calculated. A p value of <0.05 was considered statistically significant.

Results

Baseline characteristics A total of 214 couples with median (q25–q75) marriage duration of 8 (5–12) years participated in the study. Women were tested at a mean $\pm$ SD age of 32.4 ± 4.6 years and at a median (q25–q75) interval of 19.5 (11–44) months following the index delivery, while men were tested at a mean $\pm$ SD age of 36.4 ± 5.4 years ($p < 0.001$ for age at testing, women vs men). Overall, 42% of study participants had a family history of diabetes and about 60% were educated to graduate level or above; 46% of couples lived in a joint family and about 22% of women participants were employed (Table 1).

Cardiovascular risk factor analysis Dysglycaemia was seen in 123 (57.5%) women (prediabetes in 103 [83.7%], diabetes in 20 [16.3%]) and 112 (52.3%) men (prediabetes in 91 [81.3%], diabetes in 21 [18.8%]). Overweight/obesity was seen in 143 (66.8%) women and 135 (63.1%) men, and the metabolic syndrome in 89 (41.6%) women and 101 (47.2%) men (Table 2). Any one of the three (dysglycaemia, being overweight/obese or the metabolic syndrome) was present in 182 (85.0%) women and 170 (79.4%) men.

Table 1 Baseline characteristics of the study population

Variable	Women ($n=214$)	Men ($n=214$)
Time since index delivery (months)	19.5 (11–44)	—
Time since marriage (years)	8 (5–12)	—
Joint family	99 (46.3)	—
Insulin or oral glucose-lowering drug use during pregnancy	46 (21.5)	—
Education, graduate or above	133 (62.1)	125 (58.4)
Working status, employed	46 (21.5)	214 (100.0)
Age at current testing (years)	32.4 ± 4.6	36.4 ± 5.4
Family history of diabetes	89 (41.6)	91 (42.5)

Data are mean $\pm$ SD, median (q25–q75) or n (%)

Table 2 Concordance of glycaemic and cardiometabolic traits among the study participants

Variable	Women (<i>n</i> =214)	Men (<i>n</i> =214)	Concordant couples (<i>n</i> =214)	OR (95% CI) ^a	<i>p</i> value
Dysglycaemia	123 (57.5)	112 (52.3)	72 (33.6)	1.80 (1.04, 3.11)	0.03
Overweight/obesity	143 (66.8)	135 (63.1)	99 (46.3)	2.19 (1.22, 3.93)	0.01
The metabolic syndrome	89 (41.6)	101 (47.2)	51 (23.8)	2.01 (1.16, 3.50)	0.01

Data are *n* (%), unless otherwise indicated

^a Unadjusted OR for interaction of a metabolic variable between the two partners considering the spousal pair as a single unit

Spousal concordance for glycaemic and cardiometabolic traits Concordance between partners was seen in 72 (33.6%) couples for dysglycaemia, 99 (46.3%) couples for overweight/obesity and 51 (23.8%) couples for the metabolic syndrome (Table 2). Concordance for any of the three (dysglycaemia, being overweight/obese or the metabolic syndrome) was seen in 146 (68.2%) couples. On logistic regression analysis, the presence of dysglycaemia in one partner was associated with an increased risk of dysglycaemia in the other partner (OR 1.80 [95% CI 1.04, 3.11]). The presence of prediabetes (reference category: normoglycaemia) and diabetes (reference category: normoglycaemia and prediabetes) in one partner was associated with 1.64 (95% CI 0.90, 2.97) and 2.60 (95% CI 0.78, 8.67) odds of the corresponding condition in the other partner. Similarly, being overweight/obese (OR 2.19 [95% CI 1.22, 3.93]) and presence of the metabolic syndrome (OR 2.01 [95% CI 1.16, 3.50]) in one partner was associated with an increased risk of these conditions in the other partner. In the final adjusted model for covariates involving the outcome of either partner, the OR for the association of dysglycaemia and the metabolic syndrome increased while that of being overweight/obese decreased, in comparison with the unadjusted OR (Tables 3 and 4).

Comparison of glycaemic and cardiometabolic traits among partners of dysglycaemic vs normoglycaemic spouses Both women and men were more likely to have dysglycaemia if they had a dysglycaemic partner. Tables 5 and 6 show comparisons of various variables among women with normoglycaemic vs dysglycaemic partners and vice versa. Women with a dysglycaemic partner were found to have a significantly higher BMI, waist circumference and diastolic BP, and a significantly higher probability of low HDL-cholesterol (<1.29 mmol/l) and the metabolic syndrome, compared with women with a normoglycaemic partner.

Discussion

The present study shows high rates of concordance for glycaemic and cardiometabolic variables between women with a history of GDM and their spouses. Both women and

men were more likely to have dysglycaemia if they had a partner with dysglycaemia. Women with dysglycaemic partners were likely to have a worse cardiovascular profile than women with normoglycaemic partners; however, the reverse was not true.

Approximately one in three couples showed concordance for dysglycaemia, while around one in two couples and one in four couples were concordant for overweight/obesity and the metabolic syndrome, respectively. Any one of these three high-risk factors for type 2 diabetes was present in 85% of women and 80% of men, and approximately two in three couples were concordant for any of the three risk factors. Such numbers in a relatively young South Asian population speak volumes about the growing diabetes epidemic and the urgent need for novel efforts to halt this problem. In addition, we found that the presence of dysglycaemia or the metabolic syndrome, or being overweight/obese, in one partner was associated with an increased risk of the corresponding condition in the other partner. This suggests that shared faulty sociocultural and environmental risk factors predispose the spouses of affected study participants to dysglycaemia and an abnormal metabolic phenotype.

The qualitative study by Dasgupta et al indicates that women may experience greater benefits if their spouses also participate in intervention trials for the prevention of type 2 diabetes [14]. Enhanced social and emotional support and sustained motivation for positive health-related behaviours may be key elements in this. The data from our study have important implications from the perspective of interventional studies. Since spouses are themselves at high cardiometabolic risk, they would be ideal targets of intervention along with women. This would not only enhance the effectiveness of interventions for women, but also provide long-term benefits to their spouses. The approach might be cost-effective, especially in resource-limited countries, given the fact women are often accompanied by their spouse on hospital visits.

The presence of a high-risk metabolic condition in one partner was associated with an increased risk of the same in the other partner. In addition, in the adjusted analyses (Tables 3 and 4), the point estimate of OR for all three high-risk metabolic conditions (in both husbands and wives) continued to remain elevated (>1.0) despite adjustment for

Table 3 Adjusted ORs (95% CIs) for the association of a given metabolic variable for the husband in relation to the wife's metabolic variable

Variable	Model 1 ^a	Model 2 ^b	Model 3 ^c	Model 4 ^d
Dysglycaemia	2.02 (0.92, 4.44)	2.58 (0.83, 8.05)	1.63 (0.42, 6.31)	2.12 (0.47, 9.57)
<i>p</i> value	0.080	0.102	0.477	0.327
Overweight/obesity	1.16 (0.42, 3.18)	1.07 (0.30, 3.83)	1.45 (0.33, 6.30)	1.53 (0.30, 7.67)
<i>p</i> value	0.774	0.912	0.622	0.606
The metabolic syndrome	1.75 (0.56, 5.52)	2.75 (0.71, 10.67)	3.17 (0.69, 14.60)	3.70 (0.72, 19.01)
<i>p</i> value	0.339	0.144	0.138	0.118

^a Model 1: $D_H = D_W + \text{age}_H + \text{family history}_H \times D_W$; $O_H/MS_H = O_W/MS_W + \text{age}_H \times O_W/MS_W + \text{family history}_H \times O_W/MS_W$

^b Model 2: Model 1 + $\text{education}_H \times D_W/O_W/MS_W$

^c Model 3: Model 2 + $\text{marriage duration} \times D_W/O_W/MS_W$

^d Model 4: Model 3 + $\text{family structure} \times D_W/O_W/MS_W$

D, dysglycaemia; H, husband; MS, the metabolic syndrome; O, overweight/obesity; W, wife

various covariates. It was also found that study participants with dysglycaemic partners were more likely to have dysglycaemia compared with those with normoglycaemic partners. Women with dysglycaemic partners had a significantly higher BMI and were more likely to have an abnormal cardiometabolic profile, compared with those with normoglycaemic partners. Such a difference in various cardiometabolic variables was not evident when men with dysglycaemic partners were compared with men with normoglycaemic partners.

The strengths of our study are that it provides data on spousal concordance of glycaemic and cardiometabolic traits in a relatively young South Asian population, with assessment of multiple variables that are important for intervention. This is possibly the first study from the South Asian region to address important research questions pertinent to the concordance of glycaemic and cardiometabolic traits in women with a history of GDM and their spouses. The data from this study may help to provide a framework for designing diabetes prevention trials or weight-loss trials in the context of the entire family,

which may involve men as targets of interventions and not merely as supportive partners.

Our study has some limitations. Because it was a hospital-based study with a preselected group of women with GDM and their spouses, the exact interaction of the glycaemic status of men on glycaemic and cardiometabolic traits in women cannot be commented upon. The cross-sectional nature of this study also precludes us from determining the directionality of the effect between the two partners. While a population-based longitudinal study involving young married couples will be more useful in this regard, our study provides preliminary observations on various interactions. In addition, due to the observational nature of the study, we can only propose that the observed spousal concordance may provide an opportunity for targeting the 'married couple' as a whole; however, the effectiveness and feasibility of such family intervention trials will need to be determined.

To conclude, a high degree of spousal concordance for glycaemic and cardiometabolic traits in the study population may imply clustering of sociocultural and environmental risk

Table 4 Adjusted ORs (95% CIs) for the association of a given metabolic variable for the wife in relation to the husband's metabolic variable

Variable	Model 1 ^a	Model 2 ^b	Model 3 ^c	Model 4 ^d	Model 5 ^e
Dysglycaemia	1.60 (0.73, 3.51)	4.03 (1.35, 12.04)	4.32 (1.35, 13.90)	2.43 (0.63, 9.35)	3.29 (0.75, 14.50)
<i>p</i> value	0.239	0.013	0.014	0.196	0.116
Overweight/obesity	1.67 (0.73, 3.79)	0.92 (0.31, 2.75)	0.93 (0.29, 2.96)	1.30 (0.32, 5.30)	1.39 (0.29, 6.66)
<i>p</i> value	0.221	0.885	0.903	0.712	0.678
The metabolic syndrome	2.37 (1.08, 5.22)	3.70 (1.27, 10.80)	4.22 (1.33, 13.41)	3.37 (0.84, 13.50)	3.41 (0.77, 15.13)
<i>p</i> value	0.032	0.017	0.015	0.086	0.106

^a Model 1: $D_W/O_W/MS_W = D_H/O_H/MS_H + \text{age}_W \times D_H/O_H/MS_H + \text{family history}_W \times D_H/O_H/MS_H$

^b Model 2: Model 1 + $\text{education}_W \times D_H/O_H/MS_H + \text{employment}_W \times D_H/O_H/MS_H$

^c Model 3: Model 2 + $\text{insulin use during index pregnancy} \times D_H/O_H/MS_H$

^d Model 4: Model 3 + $\text{marriage duration} \times D_H/O_H/MS_H$

^e Model 5: Model 4 + $\text{family structure} \times D_H/O_H/MS_H$

D, dysglycaemia; H, husband; MS, the metabolic syndrome; O, overweight/obesity; W, wife

Table 5 Comparison of cardiometabolic and glycaemic variables for women with a normoglycaemic partner vs women with a dysglycaemic partner

Variable	Total (n=214)	Women with normoglycaemic partner (n=102)	Women with dysglycaemic partner (n=112)	p value ^a
BMI (kg/m ²)	27.6 ± 5.1	26.7 ± 4.6	28.4 ± 5.5	0.01
BMI ≥23 kg/m ²	180 (84.1)	86 (84.3)	94 (83.9)	0.94
BMI ≥25 kg/m ²	143 (66.8)	64 (62.7)	79 (70.5)	0.23
Waist circumference (cm) ^b	93.1 ± 11.0	91.5 ± 9.8	94.6 ± 11.8	0.04
Waist circumference ≥80 cm	195 (92.0)	94 (93.1)	101 (91.0)	0.58
Systolic BP (mmHg)	109.1 ± 11.5	108.0 ± 12.0	110.2 ± 11.0	0.16
Systolic BP ≥140 mmHg	4 (1.9)	2 (2.0)	2 (1.8)	0.93
Diastolic BP (mmHg)	75.6 ± 9.4	74.1 ± 8.8	76.9 ± 9.8	0.03
Diastolic BP ≥90 mmHg	18 (8.4)	6 (5.9)	12 (10.7)	0.20
Total cholesterol (mmol/l)	4.2 ± 0.9	4.2 ± 0.7	4.2 ± 1.0	0.81
Total cholesterol ≥5.2 mmol/l	29 (13.6)	9 (8.8)	20 (17.9)	0.054
LDL-C (mmol/l)	2.4 ± 0.8	2.4 ± 0.7	2.4 ± 0.8	0.77
LDL-C ≥2.6 mmol/l	83 (38.8)	39 (38.2)	44 (39.3)	0.83
HDL-C (mmol/l)	1.2 ± 0.3	1.2 ± 0.3	1.2 ± 0.3	0.11
HDL-C <1.29 mmol/l	132 (61.7)	54 (52.9)	78 (69.6)	0.01
Triacylglycerol (mmol/l)	1.2 (1.0–1.5)	1.2 (1.0–1.5)	1.2 (1.0–1.6)	0.70
Triacylglycerol ≥1.7 mmol/l	42 (19.6)	18 (17.6)	24 (21.4)	0.49
The metabolic syndrome	89 (41.6)	31 (30.4)	58 (51.8)	0.002
HOMA-IR	2.7 (1.8–4.4)	2.4 (1.7–3.9)	3.0 (2.0–5.0)	0.06
Insulinogenic index (pmol _{ins} /mmol _{glu})	122.9 (77.8–207.6)	121.5 (76.4–209.7)	122.9 (79.2–202.1)	0.67
Disposition index (l/mmol _{glu})	1.6 (0.8–3.1)	1.6 (1.0–3.2)	1.6 (0.8–3.1)	0.35
Dysglycaemia	123 (57.5)	51 (50.0)	72 (64.3)	0.002

Data are mean ± SD, median (q25–q75) or n (%)

^a Comparison between women with normoglycaemic vs dysglycaemic partners

^b n=212 (101 and 111 respectively for column 3 and 4)

Table 6 Comparison of cardiometabolic and glycaemic variables for men with a normoglycaemic partner vs men with a dysglycaemic partner

Variable	Total (n=214)	Men with normoglycaemic partner (n=91)	Men with dysglycaemic partner (n=123)	p value ^a
BMI (kg/m ²)	26.2 ± 3.9	25.9 ± 3.8	26.5 ± 4.0	0.30
BMI ≥23 kg/m ²	175 (81.8)	72 (79.1)	103 (83.7)	0.39
BMI ≥25 kg/m ²	135 (63.1)	55 (60.4)	80 (65.0)	0.49
Waist circumference (cm) ^b	95.8 ± 9.5	95.2 ± 10.0	96.2 ± 9.2	0.45
Waist circumference ≥90 cm	161 (76.3)	66 (74.2)	95 (77.9)	0.53
Systolic BP (mmHg) ^c	122.5 ± 14.4	123.1 ± 13.8	122.1 ± 14.8	0.62
Systolic BP ≥140 mmHg	23 (10.8)	12 (13.3)	11 (8.9)	0.31
Diastolic BP (mmHg) ^c	82.4 ± 11.0	82.4 ± 10.8	82.4 ± 11.3	1.00
Diastolic BP ≥90 mmHg	45 (21.1)	20 (22.2)	25 (20.3)	0.77
Total cholesterol (mmol/l)	4.6 ± 1.0	4.6 ± 1.0	4.6 ± 1.0	0.85
Total cholesterol ≥5.2 mmol/l	60 (28.0)	28 (30.8)	32 (26.0)	0.41
LDL-C (mmol/l)	2.8 ± 0.9	2.8 ± 0.9	2.7 ± 0.8	0.63
LDL-C ≥2.6 mmol/l	118 (55.1)	49 (53.8)	69 (56.1)	0.86
HDL-C (mmol/l)	1.0 ± 0.3	1.0 ± 0.2	1.0 ± 0.3	0.45
HDL-C <1.03 mmol/l	116 (54.2)	46 (50.5)	70 (56.9)	0.40
Triacylglycerol (mmol/l)	1.7 (1.3–2.2)	1.6 (1.2–2.2)	1.7 (1.3–2.2)	0.40
Triacylglycerol ≥1.7 mmol/l	105 (49.1)	41 (45.1)	64 (52.0)	0.31
The metabolic syndrome	101 (47.2)	38 (41.8)	63 (51.2)	0.17
HOMA-IR	2.9 (1.7–4.1)	2.5 (1.7–4.2)	3.0 (1.7–4.1)	0.68
Insulinogenic index (pmol _{ins} /mmol _{glu})	184.0 (97.9–339.6)	172.9 (101.4–327.1)	188.9 (84.0–361.8)	0.76
Disposition index (l/mmol _{glu})	2.6 (1.2–4.4)	2.6 (1.2–4.7)	2.6 (1.2–4.2)	0.78
Dysglycaemia	112 (52.3)	40 (44.0)	72 (58.5)	0.04

Data are mean ± SD, median (q25–q75) or n (%)

^a Comparison between men with normoglycaemic vs dysglycaemic partners

^b n=211 (89 and 122 respectively for column 3 and 4)

^c n=213 (90 and 123 respectively for column 3 and 4)

factors among individuals predisposed to type 2 diabetes. This study may provide a framework for a novel, cost-effective strategy of behavioural and lifestyle interventions targeted at the ‘married couple/family’ as a whole to control the current diabetes epidemic. However, the effectiveness and feasibility of family intervention trials based on the above strategy need to be studied in the near future.

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