Journal of Psychiatric Research 65 (2015) 166–171

Contents lists available at ScienceDirect

Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/psychires

Poor sleep quality is associated with impaired glucose tolerance in women after gestational diabetes

U. Ferrari [a, b, c, 1], H. Künzel [d, *, 1], K. Tröndle [a, b, c], M. Rottenkolber [e], D. Kohn [e], M. Fugmann [a, b, c], F. Banning [a, b, c], M. Weise [a, b, c], V. Sacco [a, b, c], U. Hasbargen [f], S. Hutter [f], K.G. Parhofer [b, c, g], S. Kloiber [h], M. Ising [i], J. Seissler [a, b, c], A. Lechner [a, b, c]

[a] Diabetes Research Group, Medizinische Klinik und Poliklinik IV, Klinikum der Universität München, Ziemssenstr. 1, 80336 München, Germany
[b] Clinical Cooperation Group Type 2 Diabetes, Helmholtz Zentrum München, Research Center for Environmental Health, Germany
[c] Deutsches Zentrum für Diabetesforschung (DZD), Germany
[d] Department of Psychosomatic Medicine, Medizinische Klinik und Poliklinik IV, Klinikum der Universität München, Munich, Germany
[e] Institute of Medical Information Sciences, Biometry, and Epidemiology, LMU, Munich, Germany
[f] Department of Gynecology and Obstetrics, Klinikum der Universität München, Munich, Germany
[g] Medizinische Klinik und Poliklinik 2, Klinikum der Universität München, Munich, Germany
[h] RG Molecular Psychology, Max Planck Institute of Psychiatry, Munich, Germany
[i] RG Psychiatric Pharmacogenetics, Max Planck Institute of Psychiatry, Munich, Germany

ARTICLE INFO

Article history:
Received 4 November 2014
Received in revised form
16 January 2015
Accepted 5 February 2015

Keywords:
Sleep quality
Perceived stress
Gestational diabetes
Glucose tolerance

ABSTRACT

We analyzed the association of sleep quality and glucose metabolism in women after gestational diabetes (pGDM) and in women after normoglycemic pregnancy (controls). Data during pregnancy and a visit within the first 15 months after delivery were collected from 61 pGDM and 30 controls in a prospective cohort study. This included a medical history, physical examination, questionnaires (Pittsburgh Sleep Quality Index (PSQI), and Perceived Stress Scale (PSS)), and 5-point oral glucose tolerance test with insulin measurements to determine indices of insulin sensitivity and insulin secretion. We used Spearman correlation coefficients and multivariate regression models for analysis.9.3 ± 3.2 months after delivery, pGDM had significantly higher fasting and 2 h glucose levels and lower insulin sensitivity than controls. There was no significant difference in age, BMI and sleep quality as assessed with the PSQI between the two groups. The PSQI score correlated with the ogtt-2 h plasma glucose in pGDM ($\delta = 0.41$; $p = 0.0012$), but not in controls. This association was confirmed with a multivariate linear regression model with adjustment for age, BMI and months post-delivery. Perceived stress was an independent risk factor (OR 1.12; 95% CI 1.02–1.23) for impaired sleep. Our findings suggest that post-delivery sleep quality significantly influences glucose tolerance in women after GDM and that impaired sleep is associated with increased stress perception. Measures to improve of sleep quality and reduce perceived stress should therefore be tested as additional strategies to prevent progression to type 2 diabetes after GDM.

1. Introduction

In epidemiologic studies, sleep disturbances are associated with several metabolic and vascular diseases, e.g. a modestly increased risk of coronary heart disease in women Ayas et al. (2003) and a higher prevalence of obesity and type 2 diabetes mellitus (Type 2 DM) in the general population (Knutson and Van Cauter, 2008). Experimental disruption of sleep in humans rapidly leads to an impairment of glucose tolerance via increased insulin resistance (Meisinger et al., 2005; Knutson and Van Cauter, 2008; Spiegel, 2008; Tasali et al., 2008; Buxton et al., 2010; Knutson, 2012; Morselli et al., 2012).

Pregnancy and the postpartum period are times during which most women experience an impaired sleep quality, both with respect to sleep duration and sleep interruptions (Mindell and Jacobson, 2000).

* Corresponding author. Psychosomatische Beratungsstelle und Ambulanz, Medizinische Klinik und Poliklinik IV, Klinikum der Universität München, Pettenkoferstrasse 10, 80336 München, DE, Germany. Tel.: +49 89 44005 3597; fax: +49 89 44005 4751.
E-mail address: heike.kuenzel@med.uni-muenchen.de (H. Künzel).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.jpsychires.2015.02.012
0022-3956/

Women with GDM represent a high-risk group for the development of Type 2 DM. The overall risk of Type 2 DM after a pregnancy complicated by GDM is increased 7.4-fold compared to women after a normoglycemic pregnancy (Reutrakul et al., 2011). A BMI of 30 kg/m^2 or more, gestational age at diagnosis of GDM of less than 24 weeks, an antenatal 1 h plasma glucose level of over 200 mg/dl and a requirement for insulin therapy have been identified as risk factors for early progression to after GDM (Kim et al., 2002).

Given the association of sleep and glucose metabolism and the very common state of 'sleep deprivation' in new mothers, we wanted to test whether impaired sleep is associated with poor post-partum glucose metabolism in women after GDM. Findings in this high-risk group were compared to a control group of women after a normoglycemic pregnancy. In addition, we tried to identify risk factors for a poor sleep quality in the post-GDM cohort.

2. Patients and methods

2.1. Study population

Data were derived from the PPS-Diab ("Prediction, Prevention and Sub-classification of Type 2 Diabetes") study. This is a prospective, mono-center observational study, which started recruitment in November 2011. The study population consisted of women who had gestational diabetes (pGDM) during their last pregnancy and women after normoglycemic pregnancy as controls in a 2:1 ratio. The cohorts were recruited consecutively from the Diabetes Center and the obstetrics department of the Klinikum der Universität München in Munich, Germany.

Eligible women were within 15 months after delivery. The diagnosis of GDM was based on a 75 g oral glucose tolerance test (OGTT) after the 23rd week of gestation. Among the women with gestational diabetes 2/3 had been treated with insulin during pregnancy and 1/3 had dietary treatment only. Women were eligible to participate as controls if they had no history of GDM in a previous pregnancy and either a normal 75 g OGTT or a normal 50 g screening OGTT after the 23rd week of gestation. Exclusion criteria for this study were alcohol or substance abuse and chronic diseases requiring medication (except for hypothyroidism and mild hypertension). Written informed consent was obtained from all study participants and the protocol was approved by the ethical review committee of the Ludwig-Maximilians-Universität.

2.2. Data collection

The first post-partum visit (6 to max. 15 months after delivery) included a detailed medical history, a physical examination including body weight and fat mass measured using a bioelectrical impedance analysis (BIA) scale (Tanita BC-418, Tanita Corporation, Tokyo, Japan). BMI was calculated as weight in kilograms divided by height squared in meters. Hip and waist circumference was assessed by tape measurement.

A 5-point 75 g oGTT was performed. During the oGTT systolic and diastolic blood pressure readings were from all subjects in a sitting position (both arms, repeated measurements, average from "higher" arm recorded).

2.3. Questionnaires

Sleep quality and stress levels were evaluated based on the following questionnaires: (i) Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989): Frequency of sleep disorder events, appraisal of sleep quality, normal bedtimes, sleep onset latency and sleep duration, ingestion of sleep-inducing drugs, and daytime tiredness were retrospectively evaluated for a 4-week period. In total, 18 items assigned to 7 domains (each with a score between 0 and 3) were used for the quantitative analysis resulting in a maximum score of 21. The higher the score, the lower the sleep quality. A common threshold for bad sleep quality is a PSQI value above 5 (Buysse et al., 1989).

(ii) Perceived Stress Scale (PSS) (Cohen et al., 1983): Measurement of the degree to which situations in one's life are appraised as stressful. The perceived stress scale has ten questions (PSS-10) about the last four weeks, coding a total score of 0 for no stress to 50 as maximum stress.

2.4. Laboratory methods

Blood was collected without stasis and was processed immediately. Plasma samples were stored at −80 °C until assayed. Plasma glucose was measured by hexokinase-glucose-6-phosphate dehydrogenase method from collection tubes containing inhibitors of glycolysis. Plasma insulin concentrations were determined by DiaSorin LIAISON® Insulin assay.

An insulin sensitivity index was calculated as described by Matsuda et al. (Matsuda and DeFronzo, 1999):

$$\text{Matsuda(/Insulin sensitivity)Index} = \frac{10000}{\sqrt{(\text{fasting glucose} \times \text{fasting insulin})(\text{mean gluc} \times \text{mean ins})}}$$

mean gluc = mean of glucose concentrations after 0′, 30′, 60′, 90′, 120′ [mg/dl]
mean ins = mean of insulin concentrations after 0′, 30′, 60′, 90′, 120′ [μU/ml]

An increased Matsuda index represents an increased insulin sensitivity as a composite of both hepatic and peripheral tissue sensitivity to insulin (Singh and Saxena, 2010).

We also validated the index in a substudy of the analyzed cohort against hyperinsulinemic euglycemic clamps.

For insulin secretion, the difference of insulin concentrations between the 30th minute and the 0th minute of the OGTT was used, which represented the best correlation to first phase insulin secretion in intravenous glucose tolerance tests performed on a separate day in a subgroup of the PPS-Diab study participants (data not shown).

2.5. Statistical analysis

All numeric values are presented as mean ± standard deviation (SD) or median (first and third quartile). Different groups were compared using the Mann-Whitney-U test. Proportions were compared using chi-squared test or Fisher's exact test. Spearman correlation coefficient (δ) was calculated for correlation analysis. Linear regression models with the dependent variable logarithmic blood glucose OGTT 120 min value and Matsuda sensitivity index and the independent variables age, BMI, months post delivery, and