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Job stress and prevalence of diabetes: results from the belstress study

by

Leynen F.[1], Moreau M.[1], Pelfrene E.[2], Clays E.[2],
De Backer G.[2], Kornitzer M.[1]

Abstract

Objectives: *In search for explanatory pathways linking job stress to cardiovascular disease, the relationship between job stress and diabetes, one of the main coronary risk factors, was assessed in a cross-sectional way in a large Belgian cohort.*

Methods: *16,335 male and 5084 female workers, aged 35-59 years, and working in a wide range of different occupations, volunteered to participate in the study. The participants completed a questionnaire and underwent a clinical examination. Non-insulin dependent type II diabetes was assessed through a question on existence of hyperglycaemia and a question on medication use; job stress was defined according to the Karasek Demand-Control model, by means of the Job Content Questionnaire (JCQ). Logistic regression analyses were performed for the scales on Psychological Job Demands (PJD), Job Control (JC) and*

Address for correspondence: Françoise Leynen, Department of Epidemiology and health promotion, School of Public Health, Université Libre de Bruxelles, Campus Erasme, CP 595, Route de Lennik 808, B-1070 Brussels, Tel: +32 2 555 40 64, Fax: +32 2 555 40 49, E-mail: fleynen@ulb.ac.be

[1] Department of Epidemiology and health promotion – School of Public Health – Université Libre de Bruxelles.

[2] Department of Public Health – Ghent University.

Social Support at Work (SSW) as well as for the combined Demand-Control scale (Job Strain). Adjustments were made for those covariates that were significantly related to diabetes prevalence. Insulin dependent diabetes cases were excluded from the analyses.

Results: *Overall type II diabetes prevalence was 2.6% in males and 2.1% in females.*

Our study provides some arguments for an inverse relationship between JC and diabetes in males (OR (95% CI) Q4/Q1: 1.50 (1.11-2.03)) and in females (OR (95% CI) Q4/Q1: 1.50 (1.15-4.01)) and for a positive association between job strain and diabetes in females (OR (95% CI): 1.92 (1.17-3.13)). In order to minimise the "self-reporter bias", sensitivity analyses were done on the relationship between these scales and consumption of oral antidiabetic medication; for males the inverse association with job control persisted as did the association with job strain for females.

Conclusions: *Even if self-reported diabetes was used in present analyses, taking into consideration the biological plausibility, these results support the idea that there is an association between job stress, defined as either a combination of high psychological job demands and low job control as well as a lack of job control alone and the prevalence of diabetes.*

Keywords

Job characteristics, job stress, stress models, demands-control-support model, diabetes, cardiovascular.

Introduction

In search for possible mechanisms explaining the relationship between job stress and cardiovascular disease, it is important to consider diabetes as a potential mediator within the pathogenic pathway. On one hand diabetes is one of the major coronary risk factors, whereas on the other hand there could also be a rationale for the association of job stress and diabetes.

Already in the 17th century, the relationship between stress and diabetes was proposed by Thomas Willis (1) and today an important number of experimental animal studies as well as clinical observations demonstrate a relationship between blood glucose level and acute stress situations (2-4).

Less is known however on the effect that chronic environmental stress could have on the incidence of glucose intolerance and diabetes.

The occurrence of major stressful life events was suggested to be a risk factor for diabetes (5) as well as "social environmental stress", as experienced for instance in populations exposed to rapid socio-economic changes (6).

In the Western industrialised world, where people spend an important part of their time at the workplace, job stress has been proposed as a possible contributor to the aetiology of diabetes.

Apart from the direct effects stress can have on health behaviours and therefore on behavioural risk factors such as cigarette smoking, excess alcohol intake or lack of physical activity, direct patho-physiological effects have been described (7-9).

E. Brunner has summarised the possible biological mechanisms linking stress to coronary heart disease (10): 1) homeostatic and allostatic changes, 2) neuroendocrine changes and alteration of the autonomic functioning, 3) development of the metabolic syndrome and insulin resistance, 4) coagulation disturbances and 5) inflammatory and immune responses. On the other hand Bjorntorp (11) formulated a concept stating that perceived psychological stress leads to an activation of the hypothalamic-pituitary-adrenal axis, resulting in an increase in serum cortisol and thus in hyperglycaemia through the effect on insulin activity.

In addition to this, the hormonal imbalance could be at the basis of visceral obesity, resulting again in an increased risk of developing type II diabetes and cardiovascular disease.

Despite this biological plausibility, studies investigating the relationship between job stress and diabetes are scarce (12-18). A possible explanation is that it is very difficult to perform a reliable and standardised glycaemia measurement in subjects at the work site, taking into consideration factors such as food intake, energy expenditure through heavy exercise and acute stress response.

Today the job stress literature is axed around two main models: on one hand the Karasek "Demand-Control-Model" (19, 20), more recently expanded to the "Demand-Control-Social Support-Model" (21, 22), and on the other hand the Siegrist "Effort-Reward imbalance / Over commitment-Model" (23). The first model states that a condition of high perceived psychological job demands in combination with low perceived control over the job, lead to a situation of strain; a situation that becomes even worse when, in addition to this, social support at the workplace is low. Beside this interactive model, low job control itself seems to be independently related to different health outcomes (24).

The model proposed by Siegrist states that stress is generated when an imbalance exists between the efforts someone puts into the job and the rewards the person gets for these efforts. The effect of this imbalance is amplified when it exists in combination with an attitude of "over-commitment at work".

Both models have been described in relation to diabetes prevalence (15-18) or incidence (12-14). Besides the use of those different models of job stress, lack of homogeneity in the definition of diabetes could partly explain the contradictory findings. Diabetes prevalence by history, fasting or post-load plasma glucose concentration, but more frequently glycosylated haemoglobin (HbA1c), a reliable indicator of impaired carbohydrate metabolism, have been used.

A relation between job stress and diabetes incidence has been observed in air traffic controllers (13) whereas a relation between job stress and elevated HbA1c was described in press-related jobs (12) and in students during examination (16). Using the Karasek model a relation of job strain with HbA1c has been reported in Japanese male employees (15) as well as in Danish workers (16) and social support at work was described to be inversely related to self reported diabetes (18). In a recent research report on the Whitehall II study, an association was described between stress, defined as effort-reward imbalance and diabetes prevalence in males, no relationship however was observed between stress, according to the Karasek model, and diabetes (14).

Material and Methods

The design and methods of the study have been described in detail elsewhere (25).

Between 1994 and 1998, 16,335 male and 5084 female volunteers, aged 35 to 59 years, working in 25 different Belgian companies and municipalities participated in the Belstress study. Overall participation rate was 48%. One of the main objectives of this prospective cohort study being to test the relationship between job stress and cardiovascular disease, a wide set of cardiovascular risk factors was assessed in order to be able to verify the potential confounding or mediating effects of these variables.

Besides an auto-administered standardised questionnaire, submitted to all participants who anonymously returned it to the company's medical department, a medical screening exam took place at the work site.

Questionnaire

Working conditions were assessed through the Karasek Job Content Questionnaire (JCQ). The Karasek model has the following scales (19-20):

First of all, the psychological job demand (PJD) scale, based on 9 questions related to psychological workload. Then there is the decision latitude, or job control (JC), scale, a combination of two dimensions, decision authority and skill discretion, constructed from 9 questions. The final scale is the social support at the worksite (SSW) scale, which is a combined scale of co-worker support and supervisor support, each assessed by 4 items.

An algorithm was used to replace up to one missing value per scale: this missing value was given the mean score computed from the set of remaining valid scale-items for that participant (26).

Job strain was defined as a combination of high psychological job demands and low job control, using gender specific medians of both scales as cut-off points. This category of "high strain" subjects was contrasted to the other categories treated together as "no strain".

History of diabetes: the subjects had to answer "yes" or "no" to the question: "has a physician ever told you that your blood sugar was too high?". Among the "yes" answers, information was collected on medication use.

Information was collected on socio-demographic variables, including age, educational level (elementary; secondary; high school or university) and marital status. Occupation was classified according to the International standard Classification of Occupations (ISCO-88) (27) divided in 3 categories [ISCO 1, 2 = Occupational class I or upper white collars (managers, professionals), ISCO 3, 4, 5 = Occupational class II or lower white collars (technicians, clerks-service workers), ISCO 7, 8, 9 = Occupational class III or blue collars (craft & trade workers-machine operators and elementary occupations)].

For smoking habits and alcohol consumption, the standardised questionnaire from the MONICA study was used (28).Physical activity was measured using the shortened and validated part of a MONICA substudy

(MOSPA) (29).For depression, the Iowa short version (11 items) of the original CES-D scale (30) developed by Kohout et al. was applied (31).

Clinical examination

Weight and height were recorded and body mass index (BMI) calculated as weight (kg)/height(m)^2. Waist and hip circumference was measured to calculate waist to hip ratio (WHR). Systolic (SBP) and diastolic (DBP) blood pressure was recorded according to the Monica protocol and hypertension was defined as a systolic blood pressure of ≥140mmHg or a diastolic blood pressure of ≥90 mmHg or an antihypertensive treatment.

Statistical analyses

In univariate analyses diabetes prevalence was compared between different quartiles of psychological job demands, job control and social support at work and between the two job strain categories, using Chi-square test to assess statistical significance of observed differences.

In multivariate analysis a stepwise logistic regression was performed, with diabetes prevalence as outcome variable and relevant covariates introduced in the model in consecutive steps: 1) age, 2) educational level and marital status, 3) hypertension, body mass index and waist to hip ratio, 4) alcohol consumption, physical activity and depression.

Analyses were done separately for males and females. Because of the smaller sample size, logistic regression was ended after the third step in women. Reference categories were lowest quartile for psychological job demands, highest quartile for job control and social support at work, and low strain category for the full job strain model. Adjusted odds ratios (95% confidence intervals) of diabetes prevalence within the different categories compared to the reference category were calculated and statistical significance of the association was based on the chi-square test for trend. Statistical analyses were executed by means of the SPSS 10.0 software.

Results

Sample characteristics are presented in table 1a and 1b

After exclusion of 33 male and 8 female insulin dependent diabetic subjects, a total of respectively 16,296 and 5082 participants were

TABLE 1a
Description of the Belstress study sample (in %)

	Males (N: 16,296)	Females (N: 5082)
Diabetes	2.6 (N:426)	2.1 (N:103)
Diabetes treatment	1.3 (N:214)	0.6 (N:30)

TABLE 1b
Description of the Belstress study sample

	Males (N: 16,296)	Females (N: 5082)
Mean age (years)	45.9	44.3
Mean BMI (Kg/M2)	26.4	25.1
Mean systolic blood pressure (mmHg)	133	127
Mean waist to hip ratio	0.94	0.81
Mean PJD	30.8	30.7
Mean JC	69.9	64.0
Mean SSW	22.9	22.6
Lower educational level	43.5%	39.4%
BMI ≥30	14.3%	13.0%
WHR ≥1.0(males) / ≥0.9(females)	19.6%	10.2%
Hypertension	42.4%	29.3%
Low physical activity	62.7%	79.9%
Alcohol consumption ≥22units/week	24.1%	6.7%
Smoking	29.6%	28.3%
Lower occupational class	39.3%	22.0%
Living alone	11.8%	20.7%
Strain category: Low strain	25.5%	27.5%
Strain category: Passive	26.9%	27.5%
Strain category: Active	30.3%	27.8%
Strain category: High strain	17.4%	17.2%

included in the analyses. Overall non-insulin dependent type II diabetes prevalence was 2.6% in males (N: 426) and 2.1% (N: 103) in females.

In males, statistically significant positive associations were observed between diabetes and age, depression, body mass index, hypertension, waist to hip ratio and marital status and inverse associations were observed with physical activity, alcohol consumption and educational level. No significant association was observed with occupational class or with smoking status. In females statistically significant positive associations were observed with age, BMI, hypertension and WHR and inverse associations were observed with alcohol consumption and educational level. No associations were observed with depression, marital status, occupational class, physical activity and smoking status (results not presented).

Comparison of crude prevalences is presented in table 2.

No statistically significant association was observed between psychological job demands and diabetes prevalence. A consistent inverse association with JC was however observed in males and females; the borderline significance in females is probably due to the smaller sample size and lower diabetes prevalence, since crude rates in the lowest JC quartile are more than double of those in the highest JC quartile. For social support at work in males, differences are statistically significant and the highest prevalence is observed in the lowest quartile.

Finally we observe in females more than twice the prevalence of diabetes in the "high strain" group compared to the "non-strain" group. No significant difference however is observed in males.

TABLE 2

Association between diabetes prevalence and job stress variables (in quartiles) – crude analyses

		males		females	
		N	Diabetes (%)	N	Diabetes (%)
PJD	Q1	4299	2.7	1396	2.4
	Q2	3668	2.9	1000	1.8
	Q3	3795	2.4	1281	1.6
	Q4	3695	2.5	873	2.1
	p		Ns		Ns
JC	Q1	2589	3.5	987	2.7
	Q2	2998	2.8	994	2.0
	Q3	3654	2.1	929	1.5
	Q4	5983	2.3	1560	1.3
	p		0.002		0.065
SSW	Q1	2179	3.3	746	2.7
	Q2	3757	2.3	1064	1.8
	Q3	1853	1.9	1547	1.4
	Q4	7027	2.9	952	1.8
	p		0.013		Ns
JS	Non high (*)	12,941	2.6	3885	1.7
	High	2700	2.8	806	3.3
	p		ns		0.003

PJD: Psychological Job Demands; JC: Job Control; SSW: Social Support at Work; JS: Job Strain.

(*): Relaxed + Passive + Active jobs.

TABLE 3

Multivariate analysis of job stress and diabetes: males

	Step 1 (age)	Step 2 (+ education, marital status)	Step 3 (+ hypertension, body mass index, waist/hip-ratio)	Step 4 (+ alcohol, depression, physical activity)
PJD 1	1 (reference)	1 (reference)	1 (reference)	1 (reference)
2	1.19 (0.90-1.57)	1.12 (0.91-1.61)	1.14 (0.86-1.52)	1.11 (0.83-1.48)
3	0.92 (0.68-1.24)	0.96 (0.71-1.30)	0.93 (0.69-1.26)	0.90 (0.66-1.22)
4	1.08 (0.81-1.45)	1.15 (0.85-1.56)	1.08 (0.80-1.47)	1.00 (0.73-1.36)
p	*ns*	*ns*	*ns*	*Ns*
JC 1	1.59 (1.20-2.11)	1.53 (1.13-2.07)	1.50 (1.11-2.03)	1.34 (0.99-1.82)
2	1.29 (0.97-1.71)	1.26 (0.94-1.69)	1.23 (0.91-1.65)	1.16 (0.86-1.55)
3	0.83 (0.61-1.12)	0.81 (0.60-1.10)	0.82 (0.60-1.09)	0.80 (0.59-1.09)
4	1 (reference)	1 (reference)	1 (reference)	1 (reference)
p	*<0.001*	*0.001*	*0.003*	*0.065*
SSW 1	1.19 (0.89-1.59)	1.17 (0.88-1.56)	1.16 (0.87-1.55)	0.99 (0.73-1.34)
2	0.83 (0.62-1.07)	0.82 (0.63-1.07)	0.83 (0.64-1.09)	0.76 (0.58-1.01)
3	0.72 (0.50-1.05)	0.73 (0.50-1.05)	0.70 (0.48-1.02)	0.68 (0.47-1.00)
4	1 (reference)	1 (reference)	1 (reference)	1 (reference)
p	*0.048*	*0.066*	*0.070*	*0.066*
JS: Non-High	1 (reference)	1 (reference)	1 (reference)	1 (reference)
High	1.12 (0.86-1.46)	1.10 (0.84-1.44)	1.08 (0.82-1.42)	0.97 (0.74-1.28)
p	*ns*	*ns*	*ns*	*ns*

TABLE 4
Multivariate analysis of job stress and diabetes: females

	Step 1 (age)	Step 2 (+education, marital status)	Step 3 (+ hypertension, body mass index, waist/hip-ratio)
PJD 1	1 (reference)	1 (reference)	1 (reference)
2	0.76 (0.41-1.41)	0.75 (0.41-1.40)	0.75 (0.40-1.40)
3	0.71 (0.40-1.28)	0.71 (0.39-1.27)	0.72 (0.40-1.30)
4	0.90 (0.48-1.66)	0.90 (0.48-1.68)	0.89 (0.48-1.68)
p	*Ns*	*Ns*	*Ns*
JC 1	2.12 (1.18-3.84)	2.03 (1.10-3.76)	2.15 (1.15-4.01)
2	1.41 (0.74-2.69)	1.42 (0.74-2.75)	1.44 (0.74-2.81)
3	1.10 (0.55-2.23)	1.10 (0.54-2.25)	1.13 (0.55-2.33)
4	1 (reference)	1 (reference)	1 (reference)
p	*0.063*	*Ns*	*0.079*
SSW 1	1.60 (0.81-3.18)	1.63 (0.82-3.24)	1.84 (0.92-3.69)
2	1.06 (0.53-2.14)	1.06 (0.53-2.15)	1.10 (0.54-2.23)
3	0.79 (0.40-1.57)	0.80 (0.40-1.58)	0.89 (0.44-1.77)
4	1 (reference)	1 (reference)	1 (reference)
p	*Ns*	*Ns*	*Ns*
JS: Non High	1 (reference)	1 (reference)	1 (reference)
High	1.88 (1.16-3.07)	1.88 (1.15-3.07)	1.92 (1.17-3.13)
p	*0.011*	*0.012*	*0.010*

Multivariate analysis

Results are presented in tables 3 (males) and 4 (females)

Neither in males nor in females has an association been observed between psychological job demands and diabetes. JC remains inversely associated with diabetes in males: after adjustment for the full set of covariates, a 34% higher prevalence of diabetes was observed in the lowest job control quartile compared to the highest; the most important difference however seems to exist between the first and the third quartile. When changing the reference category to Q3, we notice a 67% higher prevalence in Q1 compared to this reference. ($OR_{Q1/Q3}$ (95% CI): 1.67 (1.18-2.35)). In females, the difference between quartiles of job control is not statistically significant, but when looking at odds ratio's and confidence intervals, we observe, even for the full model, a twofold prevalence (with CI-limits over value 1) of diabetes in the lowest JC-quartile, compared to the highest one.

Some arguments are found for an inverse association between diabetes and SSW. In males, the association loses its significance after introducing level of education and marital status in the model, and in females the association is never significant at all; however when looking at the odds ratios in the different quartiles of SSW and in the consecutive steps of logistic regression, we notice a consistent inverse gradient in all steps both in males and females.

Finally, when looking at the two job strain categories, we notify in females a significant twofold prevalence of diabetes in the high strain group, compared to the no strain group and p-value is still below the 0.05 level in the third step of logistic regression.

In males, no difference is observed between high strain workers and subjects in all other categories together.

Relations between job stress scales and "treatment of diabetes" are presented in table 5.

Subjects taking oral antidiabetics (sulfonamides, biguanides and thiazolidinediones) were considered as "cases" in these analyses.

Since the number of "cases" was substantially reduced by this definition, we were unable to perform a logistic regression analysis as performed previously with the first definition of diabetes. In males a reduced set of covariates was entered in the model; we still notice a significant higher diabetes prevalence in the first quartile of job control, however, as already noticed in the previous logistic regression analysis, here also the most important difference is probably between this first quartile on one hand and the second and third quartile on the other hand (U-shaped association) ($OR_{Q1/Q3}$ (95% CI): 1.83 (1.08-3.08)). No significant association was observed between social support at work and diabetes, according to this definition.

For women, we only performed an age-adjusted logistic regression analysis: we still observed a statistically significant odds ratio of 2.75 (CI: 1.07-7.05) in the high strain category compared to all other categories together.

Discussion

Study limitations

In our analyses, we tested the hypothesis that job stress is associated with the prevalence of diabetes. Despite the different shortcomings we

TABLE 5

Association between job stress scales and treatment of diabetes – Logistic regression: males

	Step 1 (age)	Step 2 (+ education)	Step 3 (+ body mass index, waist/hip-ratio)	Step 4 (+ depression, physical activity)
JC 1	1.52 (1.01-2.30)	1.32 (0.85-2.05)	1.27 (0.81-1.98)	1.19 (0.76-1.88)
2	0.78 (0.48-1.27)	0.70 (0.43-1.15)	0.67 (0.40-1.10)	0.65 (0.39-1.08)
3	0.70 (0.44-1.11)	0.66 (0.41-1.05)	0.66 (0.41-1.06)	0.66 (0.41-1.06)
4	1 (reference)	1 (reference)	1 (reference)	1 (reference)
p	*0.011*	*0.024*	*0.031*	*0.047*
SSW 1	1.04 (0.65-1.66)	1.03 (0.64-1.65)	1.00 (0.62-1.62)	0.91 (0.55-1.49)
2	0.86 (0.57-1.30)	0.87 (0.57-1.31)	0.87 (0.57-1.33)	0.83 (0.54-1.27)
3	0.76 (0.43-1.35)	0.77 (0.43-1.36)	0.71 (0.39-1.27)	0.70 (0.39-1.26)
4	1 (reference)	1 (reference)	1 (reference)	1 (reference)
p	*ns*	*ns*	*ns*	*ns*
JS: Non High	1 (reference)	1 (reference)	1 (reference)	1 (reference)
High	1.06 (0.68-1.63)	1.02 (0.66-1.58)	1.08 (0.65-1.56)	0.96 (0.61-1.49)
p	ns	ns	ns	ns

have some arguments that, at least partially, the working hypothesis can be confirmed.

Study design

The cross-sectional design of the present study makes it impossible to conclude on any causality in the observed associations. Even if an acceptable pathophysiological mechanism could explain the effect of job stress on diabetes, it might as well be that diabetics perceive higher levels of stress or lower levels of job control at their work. A second assessment over time of the exposure and outcome variables would enable us to detect “incident cases” of diabetes and relate those cases to their level of exposure to job stress at baseline. One could postulate that the worst situation would then be the one where job strain was high at time 1 and time 2 and the most protective situation the one where at time 1 and time 2 no job strain would be present.

Since for the moment a sub-sample of the original Belstress cohort is being re-screened, we will hopefully be able to perform these analyses in a very near future.

Definition of diabetes

Diabetes was defined as “having answered yes to the question has a doctor ever told you that your blood sugar was too high?” This is in the first place of course a very rough approximation for real diabetes prevalence. Secondly, a “reporting bias” could be at the basis of the observed association between self reported job stress and self reported disease. As recently described by MacLeod “individuals with a tendency to negative perceptions may overreport both psychosocial adversity and symptoms of disease” (32).

Basis of this theory were findings in a cohort study, where a relationship between job stress and self-reported cardiovascular symptoms, such as angina pectoris, but no relationship with hard cardio-vascular end-points was observed at all.

In order to add some consistency to our findings, and reduce this risk of self-report bias we performed some sensitivity analyses with a more objective parameter of diabetes, namely consumption of specific hypoglycaemic medication. The results of these analyses confirm the inverse association between job control and diabetes in males as well as the association between diabetes and job strain in females.

Relationship job stress and diabetes

Even if limitations in study design and poor definition of the outcome variable make it impossible to be really conclusive about the observed findings, we think our study results are consistent enough to add some scientific argumentation to the hypothesis that job stress is related to diabetes.

To our knowledge, the only study in which “self-reported diabetes” in relation to job stress was examined, is the GAZEL study (18). No association was described here between the different job stress scales and the outcome variable. It has to be mentioned however that in this study, decision latitude or job control was assessed through a 6 item scale, contrarily to our 9 item variable; and the relationship between diabetes and the full job strain model was not examined.

The (still very few) studies having used HbA1c blood concentration as a marker for diabetes, on the contrary, do in fact observe a relationship with job stress: thus Netterström et al. observed a relationship with objective, or inferred, job strain in both sexes (17), Kawakami did observe the same association with self-reported job strain and with low social support in males (15) and in a recent communication, an association between impaired glucose tolerance test and low decision latitude as well as job strain was described in a sample of Swedish women (33).

Finally, in a recent report on the Whitehall II-study, an association between Effort/Reward imbalance and onset of hyperglycaemia (WHO criteria) is described; in this study, an association with the Karasek job stress model is not withheld.

Even if still isolated, most of the findings are in line with our results, and so it could well be that a part of the missing link between job stress and coronary heart disease is indeed explained through metabolic changes such as impaired glucose tolerance, or diabetes, in some cases part of the metabolic syndrome.

Conclusions

Present findings should incite people to continue the research on pathways explaining the link between job stress and cardiovascular disease. To the complex but plausible patho-physiological mechanism that can explain the relationship between job stress and metabolic changes, such as development of diabetes can be added arguments from the field of observational epidemiology. These factors considered all together give us enough freedom to conclude that part of the relationship between job stress and cardiovascular disease is probably explained through the mechanisms mentioned.

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