

Is a JEM an informative exposure assessment tool for night shift work?

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In this issue of *Occupational and Environmental Medicine*, Fernandez *et al*¹ investigate the role of maternal night shift work in occurrence of urogenital anomalies in offspring. The authors inferred potential exposure to night shift work by applying a job-exposure matrix (JEM)² to mothers' recorded occupations in the Australian Perinatal Registry. This study's assessment of night shift work across various occupations, with nurses reported separately from other types of workers, adds valuable knowledge on a rarely studied outcome. The authors acknowledged that the lack of individual-level information on shift schedules precluded their ability to assess differences in duration and/or intensity of night shift work, which may variably interfere with reproductive function and recommend 'investigation in a sample with more detailed exposure information'.

This is an important recommendation given the widely recognised complexity of assessing exposures in epidemiological studies of night shift work.³ 'Night shift work' refers to work that occurs during the regular sleeping hours of the general population.³ As such, it is not an exposure in the traditional sense, but rather a proxy for a complex combination of exposures and circumstances leading to circadian disruption.⁴ In addition to a wide variety of schedule characteristics, these include light at night (LAN), phase shift, sleep disturbances, disrupted social behaviours and personal habits and other workplace hazards, many of which are strongly inter-related. Moreover, personal characteristics such as age, sex and chronotype or diurnal preference may affect individual responses to night shift work.³

In a recent effort to address this complexity, the International Agency for Research on Cancer (IARC) Monograph evaluation of the carcinogenicity of night shift work³ considered various domains of night shift work exposure (eg, exposure

intensity/duration/temporality, potential for reference group contamination, shift start/end times) across the epidemiological studies reviewed. Greater weight was placed on the most informative studies, based on methodologic considerations that included night shift work assessment quality (most notably the potential for misclassification).⁵ Objective individual-level data on night shift work exposure were considered most accurate, in part due to its suitability for multidimensional exposure assessment.³

Individual-level data can be obtained from company records or collected with questionnaires, interviews or diaries wherein workers self-report their work schedules along with other relevant exposures and characteristics. When using a JEM to translate job titles into exposure to night shift work, no individual characteristics are being considered. Fernandez *et al* acknowledge that 'use of occupational title to impute night shift work involves a degree of misclassification of exposure...'.¹ Such misclassification is an inevitable and well-recognised limitation of JEMs since heterogeneity between workers within the same job is ignored by design.^{6,7} The extent of this heterogeneity varies by the agent considered and may be larger for night shift work compared with other exposures (eg, dusts) for which JEMs have been frequently used.

There are two major considerations in developing a JEM for night shift work: first, it has to be decided at the job level whether someone works at night-time. Second, various exposures and circumstances associated with night shift work (LAN, other workplace hazards, etc) could be assigned at the job level. Both steps are prone to misclassification as these aspects of night shift work are strongly related to individual characteristics and heterogeneous within jobs.

Exposure to night shift work in occupations with high proportions of night shift workers, such as nurses, might be relatively well estimated by a JEM that assigns probability by job, while occupations with less prevalent exposures will be less well characterised. However, even within nurses, night shift schedules and related exposures will vary between persons as

well as within persons over time.⁸ Further, the variety of tasks, work environments and occupational hazards encountered by different types of nurses cannot be distinguished in many job coding systems that form the basis of JEMs. As such, a JEM is inherently limited in its ability to assign night shift work with sufficient exposure contrast and nuance to assess aetiologies of health effects in the general working population.

With these considerations in mind, it is reasonable to ask: 'Is a JEM an informative exposure assessment tool for night shift work?' The JEM used by Fernandez *et al*¹ was sufficient to detect a relationship between maternal night shift work and occurrence of urogenital anomalies in offspring. This JEM, however, was developed with data from Australian females, with limited applicability to other populations.² It has been demonstrated that male workers may have very different patterns of night shift work,⁹ and circumstances of this exposure may also vary widely by region, time period and life stage.³ Less-studied groups, including gig economy workers and non-Caucasian populations, are also not well captured in this and other night shift work JEMs focused on Western working populations.

Opportunities to optimise night shift work JEM performance, such as incorporation of quantitative information on agents that may impact circadian disruption, should also be considered. For instance, noted variability in measured LAN exposures across occupations and work environments^{10,11} could be leveraged to develop grouping variables with optimal exposure contrast or to test the validity of subjective measures such as self-reported light exposures or expert assessment. A recent Canadian study observed large between-group LAN variance relative to within-group variance for various exposure metrics and groupings in healthcare,¹⁰ suggesting that high-level exposure groupings informed by quantitative measurements could be an effective means to characterise individual exposures in epidemiological studies of night shift work.

Although a JEM may be the only solution to assess night shift work in general population studies when no detailed job histories or exposure data are available, we advise caution in the application of JEMs. Due to Berkson error, a group-based approach such as a JEM will in principle not lead to biased risk estimates, but to a considerable loss of power and consequently reduced precision of the risk estimate.¹² A JEM cannot

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replace detailed individual-level information on night shift work schedules and related exposures and circumstances experienced by those undertaking them. For this reason, despite classical error, individual-based approaches to assigning exposures are often preferable for night shift work assessment. Even a few well-considered night shift work specific questions to all individuals under study may improve on the JEM approach. Therefore, research efforts in new and ongoing studies of night shift work should continue to prioritise the collection and utilisation of detailed information on various relevant characteristics of this complex exposure. High-quality exposure assessment in this field is essential to support a better understanding of night shift work's effects on health.

Contributors SP and ALH contributed equally to the conception and writing of this commentary.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Commissioned; internally peer reviewed.

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To cite Peters S, Hall AL. *Occup Environ Med* 2021;**78**:780–781.

Received 9 July 2021

Accepted 23 July 2021

Published Online First 25 August 2021



► <http://dx.doi.org/10.1136/oemed-2021-107430>

Occup Environ Med 2021;**78**:780–781.

doi:10.1136/oemed-2021-107795

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